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BONDS FOR INCREASING THE NEW YORK WATER supply, to the amount of some $4,000,000, have been authorized by the Board of Estimate and Apportionment. The proposed work includes $1,800,000 for the Brooklyn water-works, part of which will be for two reservoirs; $980,000 for the Cross River, and $300,000 for the Cross River branch storage reservoir; and $100,000 for a general investigation of the water supply for the whole city.

A MUNICIPAL CREMATORY for the disposal of human bodies was opened at Hull, England, on Jan. 2, 1901. This is the first municipal crematory of the sort in England, and one of the few in the world provided at the expense of a city or town. Last year several other municipal authorities secured parliamentary power to erect crematories and further applications are being made this year. The Hull crematory is a regenerative furnace, designed by the late Henry Simon, President of the Manchester Crematorium Society. The charge for cremating residents of the city is about $5, and for non-residents, about $15. In declaring the crematory open, the Mayor of Hull said the municipality did not wish to force cremation on any one, but it did desire to provide for those who, in the interests of sanitation, preferred burning to burial. We are indebted to the London "Surveyor" for the foregoing information.

THE TOTAL NUMBER OF DEATHS IN HAVANA for December, 1900, was 485, against 517 in 1893, the lowest total for any December during the ten years preceding. The death rate for the year 1900 is placed at 23.28 per 1,000, as compared with 27.10 for 1899. During the month of December 10,500 cesspools were examined and 550 cleaned; 1,473 houses were disinfected. These figures have been taken from the December bulletin of Major W. C. Gorgas, Surgeon, U.S.A., Chief Sanitary Officer of Havana, Cuba. The force employed under Major Gorgas includes 45 office employees, 51 sanitary inspectors and 208 laborers. The population of the city is placed at 250,000.

THE REPORT OF THE CHICAGO STREET RAILWAY Commission, an abstract of which was given in our issue of Jan. 10, 1901, has been adopted by the city council, and the bill accompanying the report will be introduced in the Illinois legislature.

MOTOR VEHICLES FOR COLLECTING CITY REFUSE have been supplied to at least six municipalities in England, according to the London "Surveyor."

THE NEW YORK STATE CANAL SITUATION, at Albany, is in a much tangled condition. Superintendent of Public Works, Col. John N. Partridge, reports a decrease in freight movement last year, amounting to 340,110 tons; and he attributes this to the wearing out of old boats, and to the fact that few new boats are being built owing to the unsettled policy of the state on the future of these canals. The friends of the barge canal, who advocate a $62,000,000 improvement, are meeting with determined opposition from those who declare that the figures named will not build the new and deeper canal; and further claim that the canal has outlived its usefulness anyhow; and that it costs 50% more now to transport freight by canal than by railway. These men go so far as to advocate filling up the state's "big malarial ditches." On the other hand, there are a number of plans for reviving canal traffic; and one of these is the Remson bill permitting capitalization of Erie Canal companies beyond the present $50,000 limit. The development of a barge traffic, they say, demands larger capital than is now permitted, and an enlargement of the canal itself so as to enable barges to carry 20,000 bushels of grain each, instead of 8,000 bushels. Systematic operation, terminals for free transfer at Buffalo and New York, and through bills of lading from the original Western point of shipment to the Eastern point of delivery, are among the things demanded.

THE PNEUMATIC TUBE MAIL SERVICE has been reported upon by Postmaster-General C. E. Smith, who appointed a committee to investigate its working in eleven cities. This committee reports that the cost of construction should not exceed $60,000 per mile for a 10-mile line; the proper annual rental for a 10-mile line should not exceed $65,761, and with government ownership this cost should not exceed $39,725. The committee, however, does not recommend this ownership until the system has been further developed. The Postmaster-General recommends the extension of the system in New York and Philadelphia. He regards the system as very advantageous, though costly.

U. S. IMPORTS AND EXPORTS in the decade ending with the calendar year 1900, says the U. S. Bureau of Statistics, show a remarkable change. In 1890 the imports were valued at $823,397,726, and the exports were $857,502,548. In 1900 the imports were worth $829,052,116, and the exports $1,478,850,854; this is an increase in the decade of less than 1% in the imports, and 72.4% in the exports. The changed relations may be tabulated as follows:

	Imports (in millions).		Exports (in millions).	
	1890.	1900.	1890.	1900.
Europe	$474	$439	$682	$1,111
North America	151	131	95	202
South America	101	102	35	41
Asia	69	123	23	61
Oceanica	23	23	17	40
Africa	3	9	4½	22

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-on collision between two double-header freight trains on the Grand Trunk R. R., near Locke's Mills, Me., on Jan. 18. Five men were killed and four locomotives demolished. The accident was due to a non-delivery of orders.

THE RAW MATERIAL IMPORT FOR 1900, says the U. S. Bureau of Statistics, exceeds that of any previous year in our history. American manufacturers imported in the year material of foreign production to the value of $275,000,000. If to this is added the total of "articles wholly or partially manufactured for use as materials in manufacturing," the grand total amounts to over $360,000,000, or nearly 45% of the total importations. In each of the two years 1899 and 1900 there was an increase of over 35% in the importation of these materials as compared with the entire period 1890-98; and an increase of 74% as compared with the years 1894-1896. The record for 1900 stands in the face of a remarkable fall in the prices of these materials in the last half of 1900. These importations are classified as follows: Food and live animals; articles in a crude condition, to be manufactured; articles partly manufactured. In a list of 12 principal imports for 1900, chemicals figure at $55,155,000; hides and skins, $50,652,000; silk, $50,652,000; India-rubber, $28,143,000; fibers, $25,528,000; wool, $19,030,000; tin, $18,680,000; wood, $15,622,000; leaf tobacco, $14,875,000; cotton, $7,627,000; furs and skins, $6,146,000; lead, $3,798,000.

THE VIBRATION FROM TUNNEL TRAINS complained of in London, is to be guarded against in New York. For this purpose experiments are being made on a 1,200-ft. section of track laid for this purpose. The roadbed is a trough of concrete laid in a similarly shaped ditch 10 ft. wide and 2½ ft. deep; the concrete is 18 ins. thick at the center and 26 ins. deep at the sides. On this the 80-lb. rails will be spiked to a continuous line of wooden sills laid on the outer sides of the trough; with the sills secured to the concrete by angle-irons. The result of this experiment will be awaited with interest, as the conditions seem to promise a firm but silent roadbed.

A TUNNEL UNDER THE EAST RIVER at 39th St., New York, is planned by the New York Gas & Electric Light, Heat & Power Co. The tunnel is intended to carry water for condensing purposes to the power plant at 39th St., and it is somewhat novel in design. The tunnel will be 225 ft. long and 12½ ft. in diameter; the metal cylinders are being made at the Lewis Nixon Shipyard; and, according to press accounts, the whole tunnel is to be completed there and then towed to its site and sunk upon a bed prepared for it, with its top 23 ft. below low water. The engineer in charge of the tunnel is Mr. Frederick M. Lande.

THE ABANDONMENT of pneumatic postal service is contemplated by the failure of the Post Office Committee of the House to appropriate any sum for its maintenance. The committee claims that the government is not getting enough for the money expended; that the rates are exorbitant, and it is better to leave the old contracts expire in the hope of obtaining more economical and more effective service. The government paid $225,000 annually for this pneumatic service, and in New York the cost of covering about 5 miles of tubes was $160,000; Philadelphia had only three-quarters of a mile, and Boston one-half mile. These tubes carried only first-class matter, and the saving in time in New York was only 25 minutes, or really 20 minutes, when the transfer of mail pouch was considered. The committee has no prejudice against the tube system, and thinks it has a future, but it does object to excessive cost in operation.

AN ELECTRICAL POWER PLANT is to be built by the Communal Council of Amsterdam, Holland, and the sum of $2,600,000 has been voted for this and other electrical work. The list includes the central power station, a tramway system 30 miles long, the electric lighting of the city, and the supply of motive power. The central station is to have a capacity of 8,000 HP., of which 6,000 HP. will be at once provided for. The power must be conveyed on the underground system; and the estimates call for $720,000 for the station and certain overhead wires; $1,440,000 for the tramway, and $440,000 for the conduits.

THE DANGER TO NIAGARA FALLS, from the rapid diversion of water for industrial purposes, is being pointed out by the Commissioners of the Niagara Falls Reservation. They claim that in the interest of preserving the lake levels—threatened by numerous canal projects, and in that of the scenic beauty of the Falls, the state should enforce its right to charge corporations or individuals for the use of this water; or to prevent its further diversion by legislative enactment. The amendment suggested to existing law on this head is vigorously opposed—as might be imagined.

THE CARRARA MARBLE INDUSTRY is described in a report of U. S. Consul Jas. A. Smith, Leghorn. The Carrara district of Italy contains 611 quarries in active operation; though the larger part of transportation from these quarries is still by ox-teams. The chief shipping port is Marina, 6 miles from the town of Carrara, and to this point a railway was built in 1890, which in 15 miles, reaches an elevation of 1,500 ft. above the sea. This road cost $4,000,000, and has not entirely supplanted the old ox-team traffic. The system of quarrying is exceedingly primitive, and little modern machinery is employed. In 1899 the total shipment of marble from these quarries amounted to 1,615,579 tons, of a total value of $27,382,500; of this, marble valued at $5,730,724, was exported to the United States. According to color and quality, the ordinary varieties are quoted at from 97 cts. to $1.60 per cu. ft. f. o. b. at Leghorn; and the finer statuary blocks at $3.50 to $7 per cu. ft. The total cost of quarrying and delivery at Leghorn is said to average 81 cts. per cu. ft.

PLANS FOR ENLARGING GOVERNOR'S ISLAND, in New York harbor, have been prepared by the War Department. A board was appointed some time ago to consider the project of the enlargement of the island to nearly three times its present area by building a sea wall around the shoal adjoining the island and then filling in. Quarters were also to be provided for additional troops; storage and shipping accommodations were to be provided for all the shipping of the army service at New York, and the buildings were to be generally rearranged. As the channels adjacent are being improved and deepened by the government, the filling material is available. An increase of 90 acres in area is recommended; for which the dike will cost about $725,000 and the filling, $160,000. For the total improvement on the island, including buildings, etc., the estimated cost is $1,595,000.

A BRIDGE OVER THE BOSPHORUS is talked of, in connection with the German concession for a railway to Bagdad and the Persian Gulf, by way of the valleys of the Euphrates and Tigris. The proposed crossing is a few miles above Constantinople, at a point where the water passage is only 1,700 ft. wide. This point is marked by the famous towers of Rumeli Hissar and Anadoli Hissar. A steel suspension bridge is proposed, high enough to permit the passage of vessels beneath. Its cost is estimated at $15,000,000, as it is to be fortified and also to be very ornate.

THE ELECTRIC LIGHTING OF RAILWAY CARS is being discussed in Germany, as a substitute for compressed gas, says U. S. Consul-General F. H. Mason, of Berlin. The question has been raised by the late accident at Offenbach-on-Main, where a rear-end collision caused the explosion of the gas tanks and the consequent loss of life by fire. The Stone system of electric-lighting is being tried between Berlin and Cologne. In this system each car carries a small dynamo, geared to the wheel-axle, and an accumulator, each being hung beneath the floor. The objection is that the varying speed and the stoppage of trains causes unsteadiness in the light, which the accumulator does not always correct. It is also said that the accidents from gas explosions are so rare that in view of the cost and technical difficulties attending the substitution of electricity, experts are divided as to the wisdom or necessity of such a change.

AN ARTISTIC DESIGN FOR A POWER-HOUSE.

Among the many places visited by the members of the American Society of Mechanical Engineers during their convention at Cincinnati last spring, none was of more interest and none aroused more enthusiasm than the works of the National Cash Register Co., at Dayton, O. The change from dingy shops and dirty streets to the commodious and elegant buildings and grounds of the famous Dayton establishment was pleasing and inspiring. It aroused the hope that at some time not distant the bulk of humanity may rise above the struggle for bare existence and enjoy the comforts and the higher pleasures of life, of which an appreciation of things aesthetic is perhaps not the least.

A departure from conventional ugliness is to be seen in the accompanying design (Fig. 1) of the new power-house now being erected by the above-named company. The architect is Mr. F. M. Andrews, and the engineer, Mr. E. A. Deeds. The new building will be of red pressed brick and will be about 160 ft. long and 120 ft. wide. The smoke-stack, which is 200 ft. high, is of the same material.

The new plant will have 1,800 rated HP. in boilers and 2,100 HP. in engines and generators Provision will be made for a future increase of 1,000 HP. in boilers, engines and generators. Fig. 2 is a preliminary sectional drawing, showing the general arrangement of the building. The boiler room will be depressed to permit of a gravity coal-handling device, and also to give a convenient location for pumps, pipes, etc., from which the engine room will be entirely free. Tunnels will be built to carry the electric cables and steam and water pipes to the different buildings.

The building and plant will be completed in about a year, and the total cost is estimated at $85,000.

For the illustrations herewith presented we are indebted to the courtesy of the National Cash Register Co.

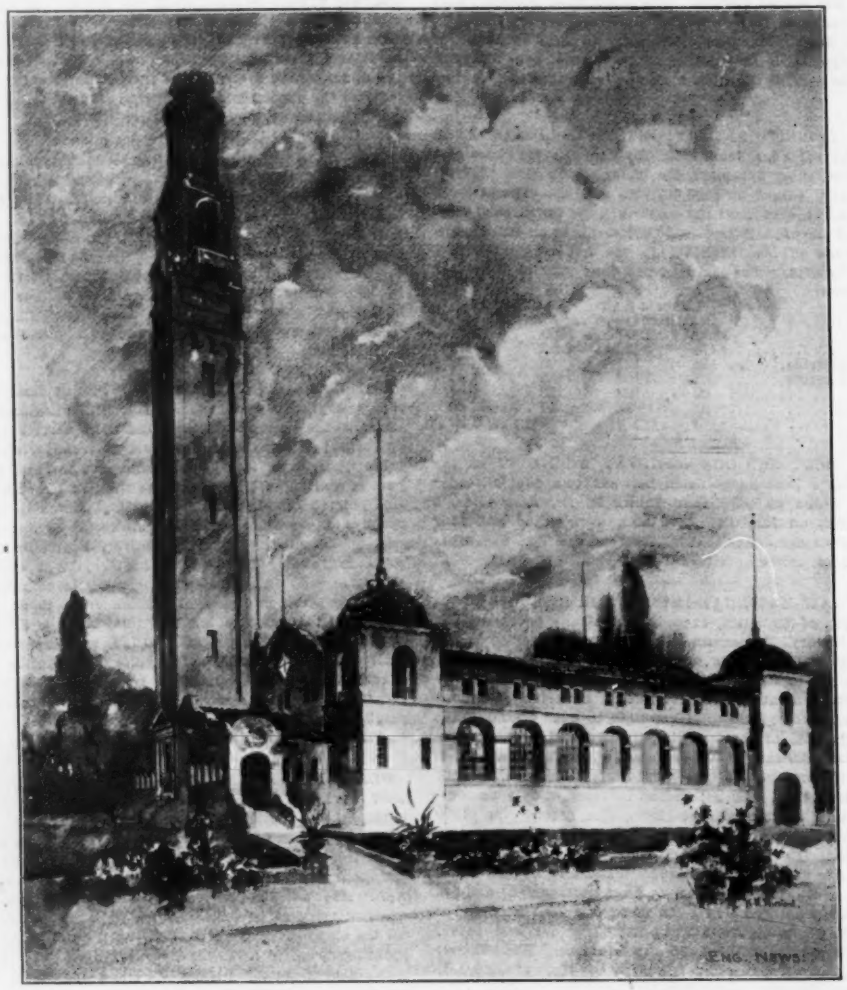


FIG. 1.—PRELIMINARY SKETCH OF POWER-HOUSE FOR THE NATIONAL CASH REGISTER CO., DAYTON, O.
F. M. Andrews, Architect.

COVERS FOR SLOW SAND WATER FILTERS.*

By Allen Hazen, M. Am. Soc. C. E.†

In warm climates filters are generally built open to the sky. In very severe climates trouble is experienced in the operation of such filters in winter, and as a precaution they are often covered with masonry vaulting, above which earth is placed. Under such a vaulting all the operations of filtration can be performed with the minimum of disturbance from cold weather.

The accompanying map (not reproduced—Ed.) shows the location of open and covered filters which have been constructed within a considerable distance, from which it will be seen that no covered filters have been constructed as far south as Trenton. Covered filters have, however, been recommended for one or two cities south of Trenton during the past year, and as otherwise this question may come up for discussion, I shall present to you in some detail the data bearing upon this point, and my reasons for recommending open filters.

In deciding whether or not to cover filters, the following points should be taken into consideration:

(1) The cost of handling and removing ice upon open filters, which would be avoided with covered filters.

(2) The decrease in efficiency in open filters, due to cleaning in very cold weather, which would be avoided by the use of covered filters.

(3) Effect of covers upon the cost of operation at other periods of the year than during cold weather.

(4) Effect of covers upon the efficiency of filters at other periods than very cold weather.

(5) The additional cost of building covered filters in comparison with the cost of open filters, taking into account, if necessary, the differences in reserve area to be provided.

*From a report to the Trenton Water Board on "Pollution and Filtration of the Delaware River Water Supply for the city of Trenton, N. J.," November, 1900.

†Consulting Engineer, 220 Broadway, New York city.

It is obvious that the first and second points depend u... the severity of the winters, and the fifth also, for t... additional reserve area, if any, depends upon the clim... It is thus necessary at the outset to find some expres... for the severity of the winters in various places. W... the subject was first taken up by the writer in 189... selected the normal January temperature as offering, ... the whole, the best and most convenient indication of ... severity of winters in different places. The January te... perature was selected because January is normally ... coldest month in the year. There are two other mont... however, which are nearly as cold, and when trouble i... experienced in operating filters in January it usually ex... tends to a greater or less extent to December and Feb... ruary, and occasionally to March, although March, as a ... rule is a warmer month. For this reason it may be th... it would be better to take the normal winter temperatur... that is, the average for the three coldest months, Decem... ber, January and February. This temperature is highe... than the normal January temperature by the following ... amounts:

In Europe:

	Deg. F.		Deg. F.
London	0.5	Paris	1.7
Hamburg	1.3	Zurich	1.9

In the United States, along the North Atlantic coast:

Boston	2.0	Washington	2.0
New York	1.7	Norfolk	1.7
Philadelphia	1.9		
		Average	1.9

In the interior of the United States:

Albany	2.7	Duluth	4.2
Buffalo	2.0	Louisville	2.5
Chicago	3.4	Pittsburg	2.1
Cincinnati	2.5	St. Louis	3.7
Detroit	2.6		
		Average	2.8

Most of the experience as to difficulty with the operation of open filters in Europe has been obtained in climates approximately on a line with Hamburg and Zurich, and, in the United States, near the Atlantic coast. The normal winter temperatures of these places are about 1.8° higher than the normal January temperatures. The divergence from this amount in no case is more than a few tenths of a degree. A difference of nearly two degrees in the normal winter temperature would be much too great to be overlooked; but as the results are simply used to compare one place with another, it is obviously a matter of no importance whether a normal January temperature of 32° or a normal winter temperature of 33.8° is taken.

Mr. George W. Fuller, in his report upon "Water Purification at Cincinnati," 1899, p. 219, has suggested another basis of comparison, namely, a consideration of the frequency and duration of periods when the mean daily temperature is 23° or less. Mr. Fuller states "that this temperature was selected because it is about as cold as experience shows that the uncovered filters will stand during scraping without serious freezing of the moist sand." Mr. Fuller discusses these data for Cincinnati at some length for the years 1888 to 1898, inclusive, and comes to the conclusion that there will often be delays of a number of days before filters can be properly scraped, and, therefore, that a considerable reserve area above that which would otherwise be required should be provided, in case open filters are built, to avoid the necessity of cleaning at these times. This result agrees entirely with that deduced from the normal January temperature, which for Cincinnati is 33.3°, by the method mentioned below. Mr. Fuller's method has not been extended to other cities where filters have been operated with known results.

This matter of covers was taken up by the writer in some detail, from the standpoint of European experience, in 1894, when he examined the available records of various European plants, visited many plants and made personal inquiries of the attendants and foremen, as well as of the directors and superintendents, as to the experience with open filters during cold weather. These results were compared upon the basis of the normal January temperatures, and, in this connection, it will, of course, be understood that the normal January temperature is not supposed to bear any direct relation to the degree of cold which will interfere with the processes of filtration, but is used only as an index of the relative severity of the climates of the various places.

In this investigation the considerations leading to the decisions to use covers or not could not always be traced in detail; but the experience of the various cities, and particularly the decisions reached in extending works, may be taken as reliable indications of the weights given to all the various points; and the results, resting as they do upon actual experience in many cities, and upon a large scale, have a certainty and value beyond those which could be derived from any theoretical considerations.

The result of the above-mentioned European examinations was, briefly, as follows:*

There was not found a single case where covered filters were used where the normal January temperature was 32° F. or above. In a few of these places some trouble was experienced in unusually cold weather, but no very serious difficulty was encountered, nor were covered filters contemplated in those places except one, and at that place

*The Filtration of Public Water Supplies: John Wiley & Sons.

recent additions to the filtering area have been open and not covered. It was further found that those places having normal January temperatures below 30° F. experienced much more difficulty with open filters, so much so that covered filters were regarded as necessary for them, although it was found that it was possible to keep open filters running with decreased efficiency and increased expense by freely removing the ice, with normal January temperatures some degrees lower than 30° F. With normal January temperatures from 30° to 32° F. there was room for doubt as to the necessity of covering filters, but covered filters were regarded as safer.

European experience in the past six years has, I believe, confirmed the results found in 1894, and a new discussion of the subject, in the light of all that has happened since, would not result in any change in the conclusions.

So much for European data. Let us see what has been done in the United States. The data upon this point are much more extensive than they were six years ago. At Lawrence, Mass., with a normal January temperature of 25°, an open filter was built in 1893. Considerable difficulty has been experienced at times from ice, and it has been repeatedly recommended to cover it, but this has not been done. Open filters have also been in use at Hudson and Poughkeepsie, N. Y., with normal January temperatures of about 24°, and although considerable difficulty has been experienced from ice at times, these filters, particularly the ones at Poughkeepsie, have been kept in

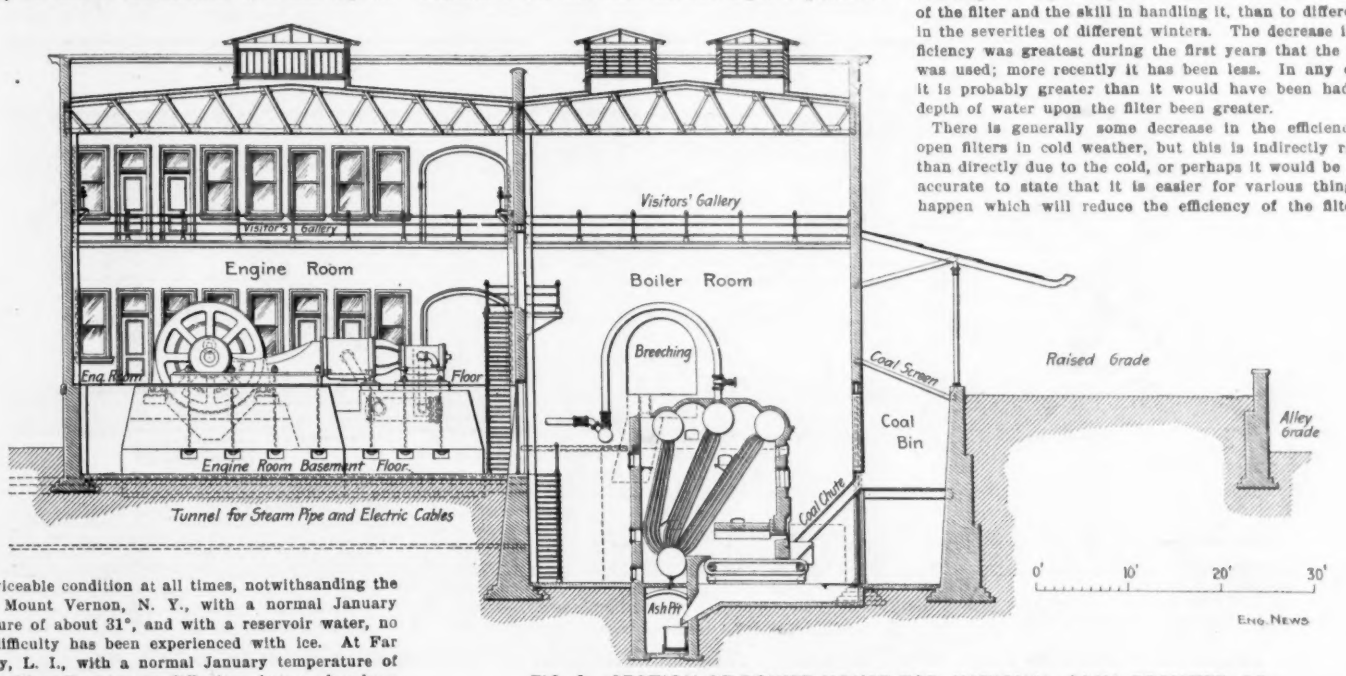


FIG. 2.—SECTION OF POWER-HOUSE FOR NATIONAL CASH REGISTER CO.
E. A. Deeds, Engineer.

very serviceable condition at all times, notwithsanding the ice. At Mount Vernon, N. Y., with a normal January temperature of about 31°, and with a reservoir water, no serious difficulty has been experienced with ice. At Far Rockaway, L. I., with a normal January temperature of 32°, and with well water, no difficulty whatever has been experienced with open filters. At Ilion, N. Y., with a normal January temperature of 23°, open filters fed from a reservoir are used, and no serious difficulty has been experienced with ice. Many other small filters have been used at places having normal January temperatures considerably below 32° without serious difficulty, but the difficulties with ice may be less than they would be in larger plants.

A number of covered filters have been built in America at places colder than the above, and also at some places that are no colder, as at Somersworth, N. H., with a normal January temperature of 24° ±, and at Albany, N. Y., with a normal January temperature of 23°. Looking at the results broadly, it seems that with normal January temperatures of 32° and above practically no difficulty has been experienced from ice; while considerable, although not unsurmountable, difficulties have been experienced at places with January temperatures as low as 24° and 25°, and in a few cases still lower, although in these cases experience would indicate the advisability of covering filters. American data are thus generally in accord with the European data. If there is any difference in practice it is in the direction of using open filters with slightly lower normal January temperatures in the United States.

Let us now consider the various points enumerated above.

(1) THE COST OF HANDLING AND REMOVING ICE ON FILTERS, WHICH WOULD BE AVOIDED WITH COVERED FILTERS.

Hardly any ice forms in filters covered with masonry vaulting. The cost of removing it is practically nil. The cost of removing ice from open filters in severe climates is considerable. At Mount Vernon, N. Y., with a normal January temperature of 31°, the cost of removing ice has ranged from 0 to 31 cts. per 1,000,000 gallons, reckoned on all the water filtered during the year, or from 0 to $172 per acre of filter surface per annum.

It is noticed that as the consumption has increased (the filter area not being extended, the relative requirement upon the filters is greater, and the cost of removing ice is increased. When the reserve filtering area was large, scrapings were less frequent, and a filter could often be held until the ice thawed, thus avoiding all expense on its account. With the plant working more nearly to its full capacity, the cost of ice removal is increased.

At Poughkeepsie, with a normal January temperature of 24°, the cost of ice removal, including the estimated additional cost of cleaning because of cold, from figures for the last three years, from Mr. Charles E. Fowler, Superintendent and Engineer, has ranged from 24 to 62 cts., and averaged 43 cts. per 1,000,000 gallons of water filtered throughout the year, or to an average of $207 per acre of filter surface per annum.

At Lawrence, with a normal January temperature of 25° F., the cost of removing ice has been quite heavy, ranging from $2 to $2.60 per 1,000,000 gallons of water filtered, reckoned on all the water filtered during the year, or to an average of about $1,000 per net acre of filter per annum.

In smaller filters in cold climates the cost of removing ice is small. Generally no separate account of it is kept.

It is apparent that the cost of handling ice on open filters will increase very rapidly, as the normal January temperature falls below 32° F., and also that it will depend upon the amount of reserve filtering area, and the character of the raw water and the length of period between scrapings, as well as upon the machinery provided for doing the work, and perhaps also upon other conditions.

Some difficulty, which would not otherwise have occurred, has been experienced with open filters in a few cases where the water upon the sand was too shallow. So far as this is the case, unfavorable experience with open filters should not be taken as applying to filters of standard construction, with four feet of water over the sand, such as are included in the estimates for Trenton.

(2) THE DECREASE IN THE EFFICIENCY OF OPEN FILTERS, DUE TO CLEANING IN VERY COLD WEATHER, WHICH WOULD BE AVOIDED BY THE USE OF COVERED FILTERS.

A number of important examples are on record where inferior effluents have been produced at times of long-continued freezing weather. Some of these have resulted in mild epidemics of typhoid fever, and this experience has been one of the most important, perhaps the most important, considerations in providing covers for filters. Most of the instances of this kind occurred years ago before the nature of filtration was as well understood as it is at present, and particularly before the special dangers from winter, and the measures to be taken to avoid them, had become known.

In general, it may be said that in winter there is some decrease in the efficiency of filtration whether the filter is covered or not. The biological changes which play an important part in the purification of water are less active at the freezing point than at higher temperatures. So far as this goes, the decrease in efficiency is just the same with covered as with open filters, for the temperatures of the sand layers and of the passing water are identical in the two cases. With careful manipulation this decreased efficiency is not important, and it is only the special decrease in efficiency which follows the cleaning of filters in very severe weather which requires particular attention.

With a filter cleaned in severe weather the sand freezes to a considerable depth, and the organisms in it are killed, or reduced to a state of inactivity, so that some time will elapse before they again establish themselves with their full vigor in the sand, and during this time purification will be less complete. Most of the bad results obtained from open filters in cold weather have directly followed the cleaning of filters in too cold weather, or else in mechanical disturbances of the sand by the ice, which can only result with inexcusably shallow water over the sand, or with a very thick ice cake.

Mr. Fuller estimates that when the daily temperature is 23° or above the cold will not be sufficient to interfere seriously with the cleaning. This, I believe, corresponds substantially with experience in other cases. While many days colder than this occur, and even a considerable number of them in succession, in climates where the normal January temperature is 32°, they are not apt to occur continuously for such long periods as to interfere unduly with the operation of filters, as Mr. Fuller has very well shown in his discussion of the Cincinnati temperatures.

At Lawrence, with a normal January temperature of 25°, the records are unusually full. They show that during several winters there has been a considerable decrease in the efficiency of filtration, while in other winters this decrease has been hardly perceptible. The differences in this respect are probably due much more to the condition of the filter and the skill in handling it, than to differences in the severities of different winters. The decrease in efficiency was greatest during the first years that the filter was used; more recently it has been less. In any event it is probably greater than it would have been had the depth of water upon the filter been greater.

There is generally some decrease in the efficiency of open filters in cold weather, but this is indirectly rather than directly due to the cold, or perhaps it would be more accurate to state that it is easier for various things to happen which will reduce the efficiency of the filter in cold weather than at other times; and while filters can be operated very well in climates where the normal January temperature is some degrees below 32° with excellent results, there is a greater chance for inferior work at such places in winter, particularly with bad or careless management.

Aside from the purely physical difficulties of operation, it is probable that a period of very severe cold, such as occurs at intervals of twenty to fifty years, as, for example, the cold which London experienced in February, 1895, may do more serious mischief in a mild climate than in a severe one; because in the severe climate the cold merely represents an increase in the intensity of conditions which are habitual and which are perfectly understood; while in mild climates such a period represents the introduction of entirely new conditions, and, because they are not understood, the operation may be less skillful and the resulting damage greater.

Devices have been invented for cleaning filters by a system of dredging below the ice without removing more than a portion of the ice and without drawing off the water. Such a system at Hamburg, Germany, has met with considerable success, and allows filters to be operated without difficulty or decrease in efficiency through the coldest weather. This system, however, is open to some objections, and while its use occasionally is very advantageous, it can hardly be regarded as a satisfactory method of regular cleaning.

(3) THE EFFECT OF COVERS ON THE COST OF OPERATION AT OTHER PERIODS OF THE YEAR THAN DURING COLD WEATHER.

Various opinions have been expressed upon this subject. In some waters there are vegetable growths in the water upon open filters which reduce the period between scrapings, and consequently increase the amount of cleaning to be done over what would be necessary with a covered filter, in which such growths would be impossible. Oc-

casionally, however, actions of another kind take place, where the sunlight appears to be distinctly beneficial in its action and longer periods can be obtained with open filters.

When the entire work of cleaning is done by hand there is probably little difference in the cost of cleaning open and covered filters, but the facilities in the two cases for the application of machinery to parts of the work are quite different. Light tramways, giving cheap transportation of sand, are much more readily installed about open than covered filters. On the other hand, it would seem possible to install an overhead carrier system in covered filters, which might possess distinct advantages, and which would not be applicable to open filters. So far as the writer knows, however, this has not been done. Existing data do not indicate any material difference in the cost of operating open and covered filters, aside from the removal of ice, except that open filters have thus far seemed rather more capable of being supplied with cheap mechanical means of sand handling.

(4) EFFECT OF COVERS UPON THE EFFICIENCY OF FILTERS AT OTHER PERIODS THAN VERY COLD WEATHER.

A great deal has been said upon this point, but little is really known. Many of the early results at Berlin and Zurich, where both open and covered filters were used to treat the same waters, have been quoted to show the advantage of open or covered filters, but it was found afterward that these differences rested mainly upon other conditions not known at the time, and which had nothing to do with the covers. The more recent literature on the subject contains much of theory but little of actual fact. Many algae, diatoms, insects and other higher organisms grow upon open filters, sometimes affecting the results favorably, and at other times unfavorably. The total result is a matter of speculation. It probably differs widely with different waters, and, in any event, is not great.

(5) THE ADDITIONAL COST OF BUILDING COVERED FILTERS IN COMPARISON WITH THE COST OF BUILDING OPEN FILTERS, TAKING INTO ACCOUNT, IF NECESSARY, THE DIFFERENCE IN RESERVE AREA TO BE PROVIDED.

The cost of masonry vaulting, like that used at Albany, Somersworth, Ashland and Superior, and at many European cities, may be taken approximately at $15,000 per acre. This is to say, covered filters will cost about this amount more than corresponding open filters. If the interest and sinking-fund charges are taken at 5%, the annual cost of the vaulting is $750 per acre. If the average yield is about 2,000,000 gallons per day per acre, this will represent a cost of about $1 per 1,000,000 gallons of water filtered.

If we compare these figures with the cost of removing ice, we find that at Lawrence the care of ice amounts to considerably more than this figure, while at Poughkeepsie, with about the same normal January temperature, the care of ice is less. At all warmer places, so far as the data are available, the cost of taking care of the ice is much less than the capital charges on the vaulting. The difference in cost of caring for the ice at Poughkeepsie and Lawrence is probably due, in larger measure, to other conditions than climate, but perhaps if we take the climate of the two places as representing about that which makes covers economical, we shall not be far out. That is to say, the point where covers will pay when compared with the cost of ice removal is where the normal January temperature is about 24° or 25° F.

Before accepting this result, however, another condition must be considered. With places having normal January temperatures considerably below 32° a larger reserve area must be provided, so that there will be no embarrassment in case of occurrence of weather so cold that filters cannot be properly cleaned for some days. The excess of this reserve area over the reserve area required for other purposes, and always necessary irrespective of the climate, which will be required at different temperatures, is perhaps a matter too intricate to admit of computation.

For normal January temperatures, near 32°, the excess reserve area is probably almost nothing. That is to say, replacing sand and some other operations taken into account in deciding upon the amount of reserve area required, will never require to be practiced during the winter, and so the reserve area necessary for them will also serve for this purpose. With temperatures considerably lower, the amount of reserve area required will become greater. This will tend to reduce the difference in cost between open and covered filters until the point is reached where the additional area amounts to 50% of the area of covered filters required. At this point, at current prices, covered filters would be no more expensive in first cost than open filters. This would be an extreme case, hardly reached in practice.

Without attempting a more elaborate discussion, which the data do not warrant, it may be said that the additional reserve area with open filters would somewhat modify our first conclusion, and that covered filters would probably be more economical with normal January temperatures somewhat above 25°, although the point would still be far below 32°. Perhaps 26° or 28° would be a fair estimate.

If covered filters were only used from motives of economy, then they would hardly be used where the normal January temperatures are higher than this. The reason for using covers in less severe climates must then lie in the greater security of bacterial efficiency obtained with them. This is, in fact, the consideration which has led to the adoption of covers in many cases. The importance of this will obviously be very different in different cases. With highly polluted waters, where a comparatively small falling off in efficiency might result in a serious epidemic of typhoid fever, it may be well to invest the money necessary to build covers, even though the probability of damage resulting from their omission is slight. The health of a community is so valuable that large expenditures are justified to avoid even a slight risk to it. Under other local conditions the construction of open filters at places having normal January temperatures some degrees below 32° may be proper and advisable.

There is no station of the United States Weather Bureau in Trenton, but observations are taken at Philadelphia and New York. The normal January temperature of New York is 30.8° F. and of Philadelphia 32.6°. These records extend over very long periods. Interpolating, the normal January temperature of Trenton is 32°. At Trenton volunteer observations have been taken extending over 15 years, by Mr. E. R. Cook, which give a normal January temperature of 33.4°. From these records, and from experience with open filters in America, I believe that there is no necessity for covering filters at Trenton, and I have based my estimates on open filters.

STANDARD BRIDGE PLANS OF THE NORTHERN PACIFIC RY.*

Ralph Modjeski, M. Am. Soc. C. E.†

About two and one-half years ago the writer was requested to revise the standard designs of steel bridges of the Northern Pacific Railway, and to complete the list by designing such spans as then remained uncompleted. At that time the railway company had a considerable number of these plans finished for a loading of two 116-ton locomotives preceded or followed, or preceded and followed by a uniform load of 3,000 lbs. As the rolling stock was rapidly increasing in weight, it became necessary to increase the standard loading to two locomotives weighing 146 tons each, with a uniform load attached of 4,000 lbs. per ft. of track. The original plan was to modify the existing designs by simply changing the sections and increasing the strength of various connections, using as many of the old drawings as possible. It soon became evident that such a plan was impracticable and would consume more time than the final result, which could not be entirely satisfactory, would warrant. The reason for this is that it is not enough to increase the sections but that lengths of cover plates, stringer and floorbeam con-

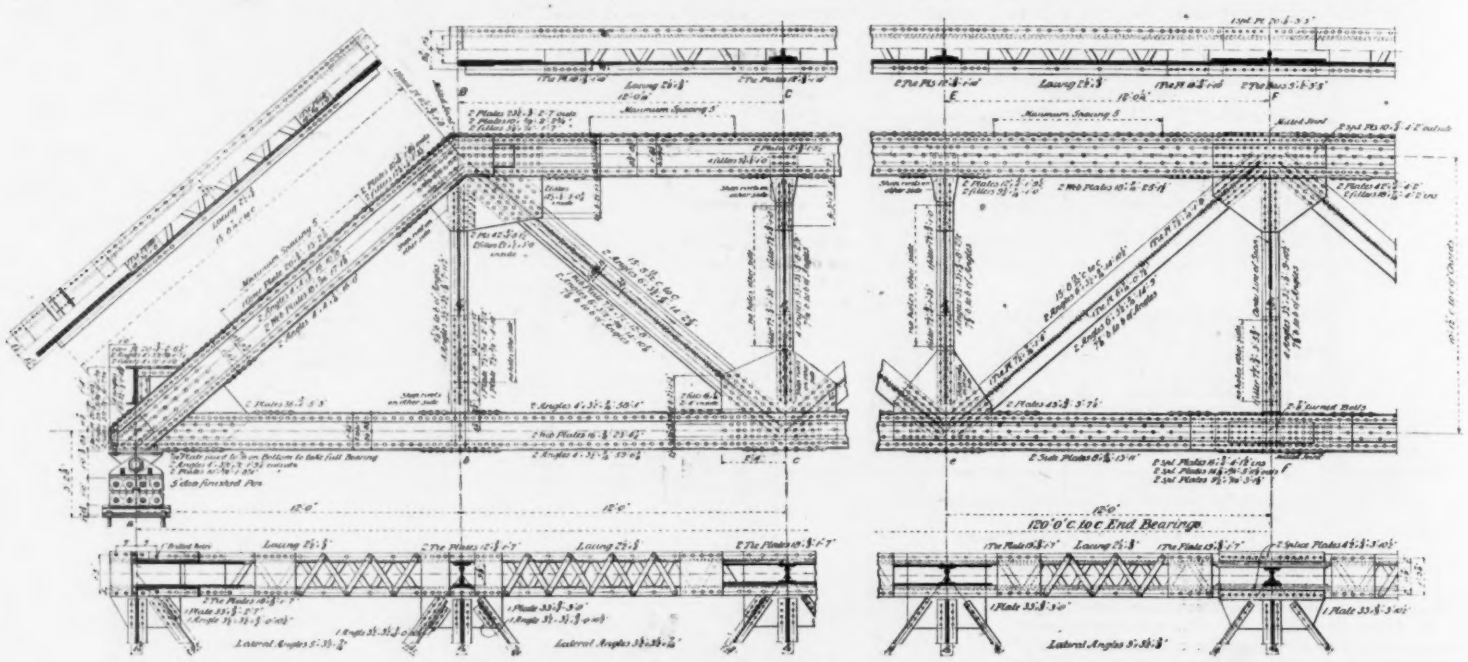


FIG. 1.—PART PLAN AND ELEVATION OF 120-FT. STANDARD THROUGH LATTICE GIRDER; NORTHERN PACIFIC RY.

nections, pin bearings and pin plates, sizes of pins, eyebar heads and a thousand other details must also be changed.

To change plans for a heavier loading can often be done in a fairly satisfactory manner without making new drawings, but only where the tonnage involved is comparatively small; that is to say, where a slight excess of metal in the sections or details would cost less than the labor of preparing entirely new plans. But when thousands of tons of bridge work may be built from a single drawing, too much care cannot be taken to have it as near perfection as to strength and economy as the shortcomings of the designer and of the present state of engineering knowledge will admit of. For this reason, and also for the reason that it became desirable to change some of the details of the old designs, an entirely new set of standards was prepared.

Before the writer became connected with this work, Mr. Geo. S. Morison, M. Am. Soc. C. E., to whom the plans were at first referred, recommended the adoption of 12-in. segmental rollers for expansion bearings, and also of the end floorbeam connection as now used in the new plans for pin-connected through spans. These recommendations were adopted, and included in the modifications.

The new set of standards consists in deck and through spans from 10 ft. to 200 ft. long, varying by 5 ft. for spans below 100 ft., and by 10 ft. for spans above 100 ft. The various kinds of structures are distributed as follows: I-beam spans from 10 to 30 ft., deck-plate girders from 25 to 100 ft., through-plate girders from 30 to 100 ft., deck lattice and pony-lattice spans for 110 and 120 ft., deck and through pin-connected spans from 130 to 200 ft. To this list has also been added a typical design of a trestle tower 30 and 40 ft. c. to c. of bents, and of deck-plate girder spans for viaducts for spans from 30 to 70 ft., varying by 10 ft. For each lattice and pin-connected deck span two types have been designed—one with end bearings near the

*Abstract of a paper to be presented before the Western Society of Engineers, Jan. 23.

†Consulting Engineer, 1742 Monadnock Block, Chicago.

top chord, and one with end bearings near the bottom chord.

The plans for all spans up to 120 ft. have been made with all detail and are actually shop plans. The plans for pin-connected spans from 130 to 200 ft. consist of strain sheets and general plans, with all details except rivet spacing and length of material. They therefore necessitate the preparation of working drawings by the contractors.

The I-beam spans are very simple and do not present any remarkable features except that they are assembled by means of bolts and wrought steel separators and require no field riveting. The I-beam spans were prepared according to a typical span designed in the office of the Northern Pacific Ry.

The practical limit of length of plate girders was taken at 100 ft. for both through and deck bridges. The flange

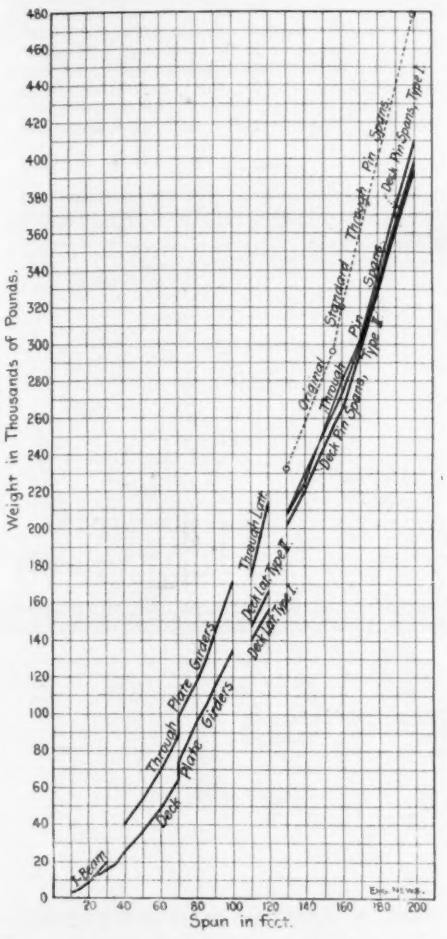


Fig. 3.—Diagram of Weights of Standard Bridges; Northern Pacific Ry.

angles and cover plates were alone considered in calculating the moment of resistance. This method had been used on the old set of standards, and, although I am of the opinion that the web should be taken into account, I decided that in the case of these standards it would be better not to do so in girders having spliced webs. In beams, such as floorbeams and stringers, where the web is continuous, the latter has been included in the moment of resistance.

All stiffeners have been crimped over the flange angles except where they connect to cross frames or floorbeams. The expansion bearings for spans up to 65 ft. have been made without rollers, and above these lengths with 12-in. segmental rollers. For spans from 50 ft. to 65 ft. a special hinge joint was designed. All shoes for hinge and roller bearings have been made of cast steel. Cast iron is only used for bed plates of fixed ends on spans having roller bearings and under plate girders 45 ft. long and less. In the former they have been made of the same height as the rollers and rail plates combined, so as to make the height of masonry the same at both ends of the span.

It is customary to have all deck spans up to about 60 ft. riveted together completely in the shop. Spans above that length, and all through spans, are shipped loose on account of difficulty in handling.

In through girders, the floorbeam to girder connection was at first designed with both end angles riveted to the floorbeam. It was intended in that way to obtain the minimum amount of field riveting with the greatest simplicity of connection. That arrangement permitted the facing of the ends of floorbeams. There was, however, considerable difficulty in assembling the girders in the field, as the main girders had to be spread in order to place the floor system. It was, therefore, found preferable to rivet one of the end connecting angles to the main girders and ship the other one loose. The drawings were changed accordingly.

There is nothing remarkable about the lattice girders except, perhaps, that the design of the pony through lattice, 120 ft. span, shown in Figs. 1 and 2, has been considerably simplified from the old design, which was published some time ago in Engineering News (Jan. 5, 1899).

The writer has also designed a typical riveted through span with overhead bracing. For a 110-ft. span this design is about 19,000 lbs. lighter than the corresponding pony-through span, but there being more field riveting to be done in the former, and, besides, the absence of overhead bracing being always a desirable feature, the chief engineer of the Northern Pacific Ry. pronounced himself in favor of the pony design.

In the through pin spans the top lateral bracing was made adjustable for two reasons: First, because it is lighter, the stiff bracing requiring considerable excess of metal; and, second, because the top chord can be thoroughly lined up by adjusting the rods. The bottom lateral bracing has been made of angles riveted to the bottom flanges of stringers by means of lugs. The stringer bracing consists of diagonal angles riveted to the top flanges and one cross frame at the center of each panel. In the deck spans this bracing is similar, except that no intermediate cross frames have been provided, the bottom flanges of stringers being rigidly held by the laterals.

The 130-ft. through span has a stiff bottom chord throughout. The longer spans have the usual stiff bottom chord in the two end panels.

In the pin-connected deck spans, the bottom lateral system is left out. Each pair of vertical posts has its sway frame, and the wind and vibration stresses are carried down the inclined end posts by means of a very strong cross frame. A somewhat unusual connection has been designed for the top lateral angles:—the lateral plate is riveted to the top chord, the bottom flange of the stringer and the top flange of the floorbeam.

In all pin spans the balancing of the compression chords and end posts having cover plates is done by using four angles, two inside and two outside at the lower flange. The lacing attaches to the inside angles wherever such are used.

All end shoes in all spans are of cast steel. The rollers are of forged or cast steel and are of uniform cross section for all bearings. Fig. 3 is a diagram of weights. The full lines show weights of the present standards. The dotted line shows the weights of some through pin-connected spans calculated for the same loading and actually built. These spans are the result of modifying the original Northern Pacific Ry. standards, which were designed for a lighter load, to carry the present standard loading. This was done in a few instances before the present standards were completed, and show what can be done by careful designing. In the case of the 200-ft. span, the original design modified by a bridge company, weighed 479,500 lbs., while the present standard weighs 410,000 lbs.

The structural material in the new standards is all medium steel, reamed. The die for punching is specified 3-16-in. smaller than the nominal diameter of rivet.

THE CHARLESTOWN SWING BRIDGE, BOSTON, MASS.

(With two-page plate.)

To improve the street transit facilities across the Charles River, between Boston and Charlestown, and to give the new Boston Elevated Railway a suitable means of crossing the same stream, it was decided in 1896 to remove the old Charles River Bridge and replace it by a heavy steel structure, of modern type. This new bridge, known as the Charlestown Bridge, was completed in the early part of 1900, and has been open to traffic for some months. The bridge as completed is particularly remarkable for its width of 100 ft., which is continuous over the swing span, for being a double deck structure throughout, and for the heavy and solid character of its substructure and foundation work. Some new details of the foundation work have been given in Eng. News, 1898, Vol. I., p. 181, and in shorter items published previously. Regarding the details of the superstructure, practically nothing has been published, and the following extracts from the annual report of the Boston Transit Commission, which has just been issued, with the drawings from the same report reproduced on our two-page plate will, we think, be of interest to our readers. We are indebted to the Boston Transit Commission, through Mr. William Jackson, M. Am. Soc. C. E., Chief Engineer of the bridge, for advance sheets of the report from which these extracts have been made:

GENERAL DESCRIPTION.

The new bridge runs from Keany Square in Boston to City Square in Charlestown, passing over the Charles River, Water St., and a branch of the Fitchburg R. R. Including the approaches it is about 1,900 ft. long. Its width is 100 ft., comprising two sidewalks each 10 ft. wide, two carriageways each 27 ft. 9 ins. wide in the clear, and a middle space 22 ft. wide for electric cars. Over the car space are the elevated tracks of the Boston Elevated Ry. Co.

Starting from Keany Square the new street rises at the rate of 3 ft. per 100 ft. to the edge of the river, and continues to rise at the same rate nearly to the southerly draw channel. It passes over the two draw channels on a level grade at a height of 38 ft. 6 ins. above city base, and then descends at the rate of 0.8 ft. per 100 ft. to the Charlestown shore, and at the same rate to and across the tracks of the Fitchburg R. R., over which it passes at a height of about 18 ft. 3 ins. above the tracks, giving a clear passage 16 ft. high under the structure. Thence, curving to the right and passing over Water St., it descends at the rate of 3 ft. per 100 ft. into City Square.

The two draw channels for the passage of vessels are each 50 ft. wide. The height of the under side of the draw above mean high water is 23 ft. The south draw channel is for vessels passing up or down the river, while the north draw channel gives access to the spans, enclosed by the Warren Bridge, the new bridge, the Charlestown shore, and the fender piers of the two drawbridges.

The main gas pipe of Massachusetts Pipe Line Co. is laid in the space under the floor of the new bridge, between the girders of the fixed spans. It is not attached to the girders, but rests in cradles placed on top of the stone piers. It crosses under the two draw channels and the space between them by a tunnel just east of the bridge. The principal dimensions of the Charlestown Bridge are:

	Ft.	
Length of Boston approach	207	
" of Charlestown approach	603	
" of bridge over river	1,090	
Total length, including approaches, ft.		1,900
Length of draw, ft.		240.5
Number of fixed spans over river		10
Length of fixed spans over river (each), ft.		85
Width of bridge, ft.		100
Weight of draw, tons		1,200

RIVER SPANS.

Each of the ten fixed spans over the river consists of six steel plate girders 84 ft. 4 ins. long and 8 ft. 3 ins. to 8 ft. 9 ins. deep. Cross-sections of these spans are shown by Fig. 2. Transverse floor beams, crossing from girder to girder, support the longitudinal stringers, which are steel I-beams. Along the top of each steel stringer is bolted a spiking strip of hard pine, across which the floor planking is laid transversely of the bridge. The floor planking is of hard pine planed to a uniform thickness from 6-in. stock. Each plank is secured to the spiking strips by 10-in. wire spikes, and the planking is coated on top with a preservative compound. On the planking is laid a waterproofing layer, consisting of four thicknesses of roofing felt laid in roofing pitch. The rails for the street cars are laid on cast-iron plates resting on the waterproofing, and are spiked to the floor planking. The waterproofing is protected by a 1-in. layer of concrete composed of road pitch and sand. The wearing surface of the roadway is of granite blocks laid upon a thin bed of sand, with the joints between the blocks filled with pebbles and road pitch.

The sidewalk floor beams rest directly on the top of the outer girders of the bridge and are anchored to the road-

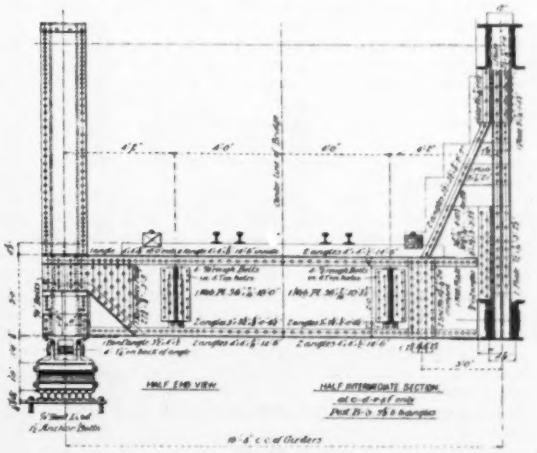


Fig. 2.—Part End Elevation and Transverse Section of 120-Ft. Through Lattice Girder; Northern Pacific Ry.

way floor beams by means of a web. At their outer ends they bear a fascia which gives the outside finish to the edge of the bridge and furnishes support to the outer edge of the sidewalk. At their inner ends they bear a longitudinal channel-iron to which is attached a cast-iron

gutter curb. The immediate support of the sidewalk paving is of pressed steel buckle plates riveted at their edges to the floor beams, fascia, and longitudinal channel. The hollows of the buckle plates are leveled up with pitch concrete, upon which is laid a wearing surface of asphalt. At the outer edge of the sidewalk there is a strong and simple iron railing 3 ft. 7¼ ins. high.

The top of the curb is 6 ins. higher than the stone paving at the edge of the roadway. Between the curb and the stone paving is a continuous longitudinal slit kept open by separator blocks. This opening is intended to provide for the surface drainage of the roadway and for the difference in expansion between the roadways and the walks. The ends of the floor planks are protected from the drippings by a flashing of sheet copper, and the drippings are diverted from the floor beams and from the piers and abutments by copper gutters.

Between the flooring planks at the ends of adjacent spans, and at the two abutments, an opening 3 ins. wide is left. This span is closed with a copper flashing so corrugated as to allow the opening to change its width as the spans expand and contract with changes of temperature. Over this expansion joint the paving is laid continuously. Expansion between the sidewalks of adjacent spans is provided for by a sliding plate finished on its upper side with a safety tread.

The posts supporting the elevated railway are placed alternately at mid-span and over the piers of the bridge. Those at the pier stand directly on the masonry; those at mid-span are attached to special cross-girders put in by the railway company. In both cases the posts pass through holes left for that purpose in the floor planking. The stone paving is retained in place and prevented from touching the posts by a curb casting having an opening of 18 ins. × 26 ins. At the post holes, as at the endges of the roadway, the floor planking is protected from moisture by a copper flashing.

Of the ten fixed spans, all but the two adjacent to the draw are exactly alike, and these two differ only in having an overhang and other details at the ends towards the draw span, and in having provision for the change of gradient of the bridge from the level grade of the draw to the decline towards Boston, and that towards Charlestown. The main girders of the fixed spans rest in pin-bearing shoes. The shoes at that end of each span towards the middle of the river are bolted to the pier masonry. The shoes at the shoreward end of each span are provided with a roller bearing to allow of expansion and contraction of the girders with changes of temperature.

DRAW SPAN.

The draw span is a swing or turntable draw 240 ft. 6 ins. long and 100 ft. wide between centres of sidewalk railings. It has two sidewalks, two roadways for street traffic, one roadway for surface street cars, and one floor above the latter for a double-track line of the Boston Elevated Ry. The main trusses are four in number, of the pin-connected type, and discontinuous when the draw is in position for travel. The floor beams, sidewalk brackets and beams and stringers of the elevated railway floor system are built sections, and roadway and sidewalk stringers are rolled beams provided with nailing pieces of hard pine. The sidewalks are covered with 2-in. hard pine plank, and the roadways with 6-in. kyanized spruce, upon which a wearing surface of 2-in. spruce is laid. Plan of draw and section of floor is shown in Fig. 2.

The draw is so designed that when swung clear of its end supports its entire dead load is concentrated on the four tower posts of the inside trusses, the outside trusses being hung to them by two transverse trusses shown in the section Fig. 3. The spaces occupied by the middle panels of these trusses being required for the passage of the elevated trains, it was not practicable to counterbrace them, and therefore unbalanced live loads on the outside trusses are transferred to the turntable by cantilever girders to which the trusses were connected by apjustable shoes after the draw was swung. The weight on the four tower posts of the inside trusses is carried to eight equidistant points on the turntable drum by a system of heavy plate girders.

The turntable drum is 54 ft. in diameter, with planed steel track, and rests upon 70 steel wheels 27 ins. mean diameter. The lower track is planed steel attached to a bed casting. The turning mechanism of the draw span is shown by Fig. 4, and consists of two trains of gears driven by electric motors and engaging with a circular rack fastened to the bed casting of the lower track. The motors are operated from a controller in the power room. A strap brake operated by compressed air is connected with the main shaft of each train of gears, the purpose of these brakes being to control the draw span in high winds, and retard its motion when necessary. The power of these brakes is such that no damage to the turning mechanism can result from their use. The ends of the draw span are provided with hydraulic jacks for bringing them to the proper grade for traffic. The cylinders of these jacks transfer the weights at ends of trusses to movable landing blocks inserted between them and the draw landings, these blocks being operated by the gateman at each end of the draw span. The draw landings and jacks are shown by Fig. 5.

All the operations incident to turning and adjusting the draw span, except the moving of the landing blocks, are controlled from a power room located between four of the distributing girders of the turntable, the plan and section of the power room being shown by Fig. 6. The hydraulic jacks under the ends of the main trusses are operated by a special mineral oil kept under pressure by compressed air in a set of accumulators consisting of heavy steel tubes. The initial air pressure in the accumulators is obtained from an air-compressor of 1,000 lbs. per sq. in. capacity, and the required operating pressure obtained by pumping a proper quantity of oil into them.

An automatic air-pump connected with an air-tank supplies air for operating the air-brakes and an oil ejector. All the machinery in the power room is driven by electric motors, and the room is lighted and heated by electricity. An electric signal system is provided for the general operation of the draw span, and an emergency system, including speaking tubes, affords means of further communication between the operator and the gatemen. A target is provided to assist the operator in bringing the draw span into the proper position for traffic, this target being electrically illuminated at night.

In operating the draw span, its ends are first lifted clear of the landing blocks, and the blocks withdrawn by the gatemen. The pressure on the jacks is then relieved and the ends of the span allowed to settle to their swinging level, the plungers of the jacks being meanwhile lifted clear of the draw landings by counterweighted levers. When the draw span returns to its position over the landings, the ends are lifted about ½-in. above the proper grade and after the landing blocks are inserted, allowed to drop into bearing upon them. In case of air accumulating in the pipes near the jacks, the flow of oil from them is accelerated by the use of an ejector. The time required for the operations just described, and the turning of the draw span through 180°, seldom exceeds 4½ minutes, the additional delay to traffic on the bridge being ordinarily due to the time taken by the passage of the vessel.

For the 2,701 times the draw span was opened from Nov. 27, 1899, to Aug. 15, 1900, the average delay to traffic per opening was 6 mins. 52 secs.; for 312 openings from June 15 to July 15, 1900, 6 mins. 15 secs.; and for 341 openings from July 15 to Aug. 15, 1900, 5 mins., 58 secs. For the year ending Nov. 27, 1900, 8,661 vessels passed through the bridge, the draw span being opened 3,856 times for the passage of 6,533 vessels; 2,128 vessels passed under the draw span, for which 1,691 additional openings would have been made had the bridge been built at the ordinary grade. The average delay to traffic per opening for the year above noted was 6 mins. 34 secs., and for the five months ending Dec. 1, 1900, 5 mins. 59 secs.

After an operation of the draw span the air pressure in the accumulators is regained by pumping into them the amount of oil used in the jacks in lifting the ends of the span. The loss of air from the accumulators is replenished from time to time by the air-compressor working in combination with the hydraulic pumps.

All steel work in the bridge was painted with one shop coat of red lead. The draw span, railings, and outside faces of the river spans received two coats of a special varnish paint made by Edward Smith & Co., New York, and the balance of the steel work two coats of durable metal coating, made by the same firm.

The approaches to the bridge on both sides of the river are earth embankments between masonry retaining walls, except at street crossings, where abutments are built to carry I-beams between which brick arches are sprung. These I-beam girders are supported at the middle by a steel trestle bent in one case, and a masonry pier in the other case.

The contractors for the superstructure were A. & P. Roberts Co., Philadelphia, Pa., for eight river spans and two shore spans, and the Pennsylvania Steel Co., of Steelton, Pa., for two river spans and the swing span.

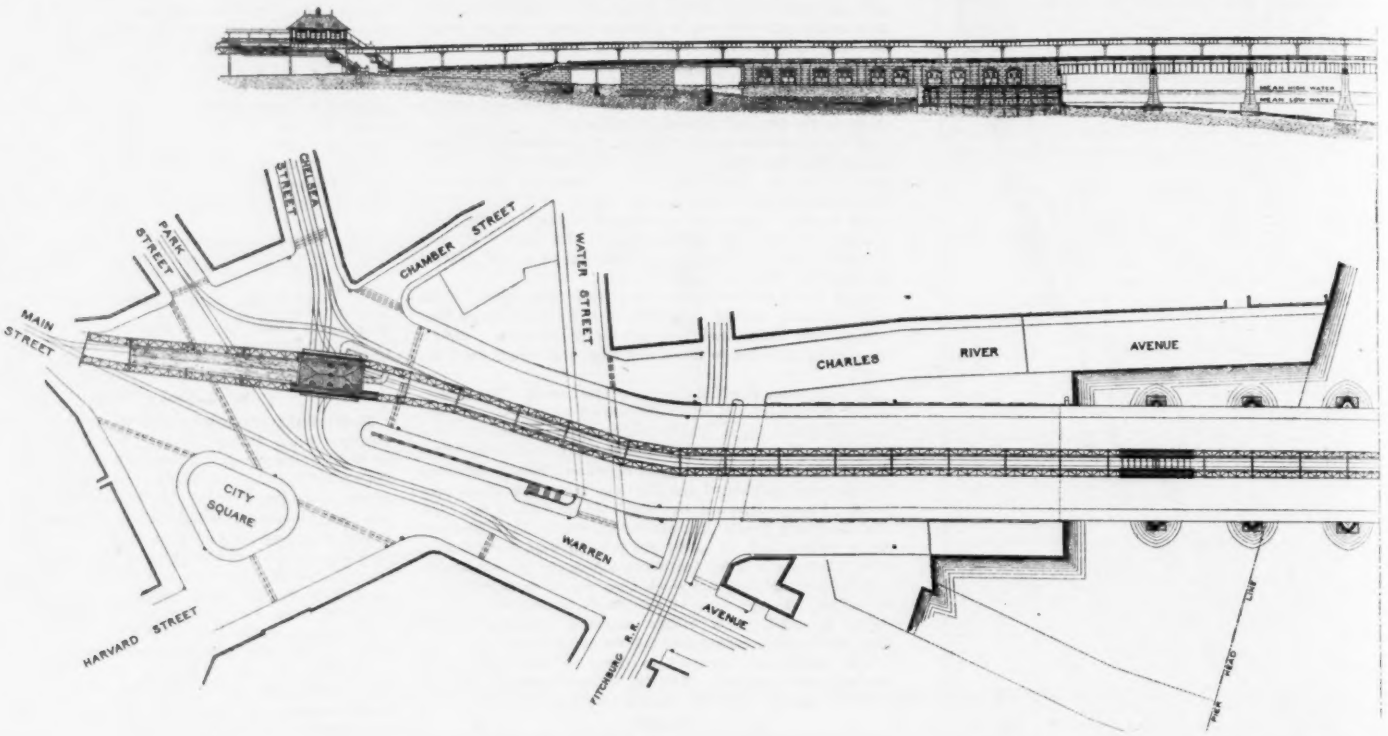


FIG. 1.—GENERAL PLAN AND ELEVATION;

BOOK REVIEWS.

ELECTRIC WIRING TABLES.—By W. Perren Maycock, M. I. E. E. New York and London: Whittaker & Co. Leather; gilt edges; 3 x 4 ins.; pp. 144. $1.00.

As stated in the preface,

this book of tables is chiefly intended for those engaged in electric fitting, but will * * * * be found of some service to electrical engineers generally.

The tables are very complete and would be most useful in laying out wiring, but their value in America is diminished by the fact that all measurements are given in British units and that no tables are given for alternating current wiring.

THEORY AND CALCULATION OF ALTERNATING CURRENT PHENOMENA.—By Charles Proteus Steinmetz, with the assistance of Ernst J. Berg. Third Edition, Revised and Enlarged. New York: The Electrical World and Engineer. Cloth; 6 x 9 ins.; pp. 525; 210 illustrations. $4.

In the present edition of this valuable book a considerable portion has been rewritten and many improvements have been made. New chapters on the vector representation of double frequency quantities and the symbolic representation of general alternating waves and other subjects have been added. Mr. Steinmetz has given us the most direct and comprehensive methods of treating the subject of alternating currents that has yet appeared, and the further extension of those methods in this new edition of his book will increase the great popularity that the work already possesses with engineers.

DYNAMO ELECTRIC MACHINERY, Its Construction, Design and Operation. Direct-Current Machines.—By Samuel Sheldon, Ph.D., Professor of Physics and Electrical Engineering at the Polytechnic Institute of Brooklyn, assisted by Hobart Mason, B. S. New York: D. Van Nostrand Co. Cloth; 5½ x 8 ins.; pp. 281; 202 illustrations. $2.50.

This book is intended primarily for use in technical schools and should be of great value when supplemented by verbal instruction and work in the laboratory and shop. It is logically arranged and clearly written and will enable the student to form accurate ideas concerning the fundamental laws of electrical machinery. For use as a reference book, however, the present work should be greatly amplified and better illustrations, taken from the latest modern practice, should be introduced.

HILFSBUCH FÜR DIE ELEKTROTECHNIK.—Von C. Grawinkel und K. Strecker. Unter Mitwirkung von Borchers, Eulenberg, Fink, Pirani, Seyffert, Stockmeier und H. Strecker, bearbeitet und herausgegeben von Dr. K. Strecker, Kaiserl. Ober-Telegraphen-Ingenieur, Professor und Docent an der Technischen Hochschule Berlin. Sixth enlarged and improved edition. Berlin; Julius Springer. Cloth; 5 x 8 ins.; pp. 732; 330 illustrations. $3.60.

This is a most excellent hand-book of electrical engineering, such as does not at present exist in the English language. It is thoroughly up to date, the seven sections having been prepared by specialists in the respective subjects. Short descriptions are included of the characteristic types of apparatus manufactured by the German firms.

TECHNISCHE MECHANIK.—Ein Lehrbuch der Statik und Dynamik für Maschinen—und Bauingenieure, Herausgegeben von Ed. Autenrieth, Oberbaurath und Professor an der K. Technischen Hochschule in Stuttgart. Berlin: Julius Springer. Paper; uncut edges; 6½ x 9½ ins.; pp. 558; 327 illustrations. $3.60.

This is a treatise on theoretical mechanics with especial regard to its applications in civil and mechanical engineering. The calculus is extensively used, as is necessary in a thorough treatment of this science, and graphical diagrams are freely added wherever they will make the text clearer. The theories and generalizations are illustrated by application of the same to problems arising in engineering practice. The author has endeavored to make the work at the same time thoroughly practical and rigidly scientific.

TRAVAIL DES METAUX DERIVES DU FER.—Par L. Gages, Capitaine d'Artillerie. Encyclopedie Scientifique des Aide-Memoire. Paris: Gauthier-Villars, Quai des Granda-Augustins 55. Paper; 4½ x 7½ ins.; pp. 202; illustrated.

In this treatise the author sets forth the properties and the methods of producing and treating all metals derived from iron. After explaining the composition of industrial iron he takes up the practice of making iron, its remelting and furnace treatment, the determination of high temperatures by the pyrometer, etc., mechanical transformation by heat; the effect of forging, rolling, stamping, etc., and tempering. This is followed by the theories of Tchernoff, Osmond and Werth as to the mechanical transformation accompanying the change from iron to steel, and with this is given the Werth classification of tempers into positive and negative groups. The second division deals with carbon steels and their mechanical properties as determined by various tests. The third and last division discusses the relations between the general properties of steels and their chemical composition, according to the law laid down by Roberts-Austen, of the Royal Society of London. This discussion is divided into two series; the first including so-called carbon, nickel and manganese steels, and the second, chrome and silicon steels. A bibliography of works consulted concludes the treatise.

THE COLOMBIAN AND VENEZUELAN REPUBLICS.—By William L. Scruggs, Late Envoy Extraordinary and Minister Plenipotentiary of the United States to Colombia and to Venezuela. Boston: Little, Brown & Co. Cloth; 5¼ x 8¼ ins.; pp. 350; three maps and 10 illustrations. $2.50.

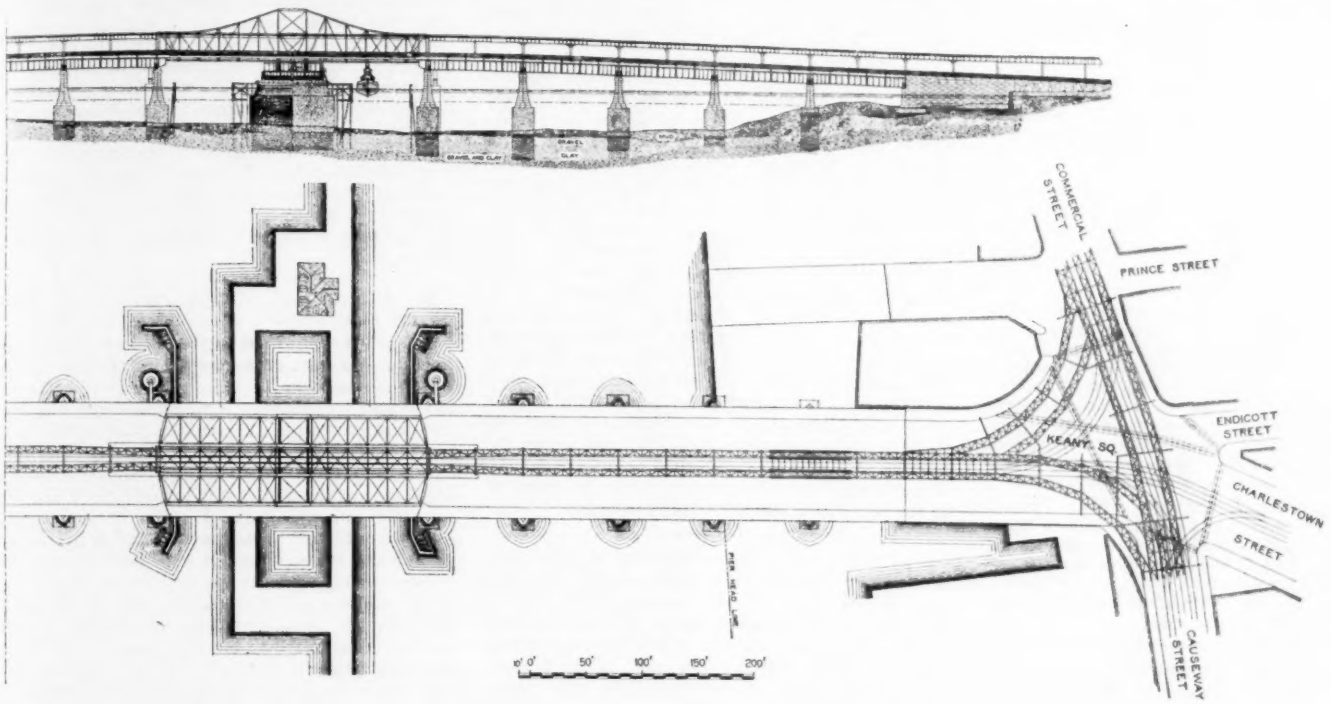
The author, who has spent 27 years in Colombia and Venezuela, has written a useful book both for travelers and persons interested in the Republics. The second chapter, entitled "Panama Canal Projects," gives a brief description of the various schemes for a canal at Panama since Gen. Simon Bolivar's first effort to interest foreign capital. Other chapters treat of the rights of foreigners in South America, Colombia and its possibilities, the staple products and mineral resources of Venezuela and the general condition and manners of the countries and their people. The hints as to modes of living and native customs and the legal status of foreigners in Spanish American countries make the book a useful one to engineers and others who have occasion to visit them.

FIELD MANUAL FOR ENGINEERS.—By Philetus H. Philbrick, C. E., M. S., Chief Engineer Kansas City, Watkins & Gulf R. R., Lake Charles & Gulf Coast R. R., etc., sometime Professor of Civil Engineering at the State University of Iowa. New York: John Wiley & Sons. Leather, with flap; 4 x 6¾ ins.; pp. 388; diagrams. $3.00.

In presenting to engineers a new manual, the author has aimed to arrange the subjects in a mathematical and logical order; to classify problems so as to be easily referred to; to express his formulas in the form requiring the least numerical computation; to furnish a larger number of useful tables and to extend them; and to treat railway problems at more length than is usually done. An inspection of the manual shows a more logical sequence of problems, and a much wider range of these problems than is generally found; but in the space available it is difficult to do more than to outline this arrangement and scope. Beginning with the preliminary operations of a survey and the adjustment and care of instruments, a chapter on plane trigonometry introduces the simple curves connecting straight lines, and the many problems arising out of these relations. Leveling and stadia measurements come next; and then we have a very full discussion of compound curves, with special problems; reversed curves and turnouts. In a separate chapter the author gives his "true transition curve," and numerous special problems and examples. In connection with the computation of earthwork, the formulas in use are abridged and the general relations between the "end-area" and the "middle-area" volumes is shown by symbols. The final chapters relate to abridged computation, and some observations upon construction methods, "staking-out," etc. The 24 tables given include a number not usually found: such as correction for curvature and refraction, coefficients for stadia and gradienter, offsets, tangent distances and deflection angles for transition curves, acres for various lengths and widths, tangent and arc offsets, etc. Room is made for these additional tables by entirely omitting the usual logarithmic tables, which, as the author claims, are now little used in field work.

A TREATISE ON WOODEN TRESTLE BRIDGES.—By Wolcott C. Foster. New York: John Wiley & Sons. Cloth; 9 x 12 ins.; pp. 271; illustrated. $5.00.

This is the third edition of this well-known treatise on timber trestle construction according to the most recent practice of American railways, and it is quite unnecessary to do more than call the attention of our readers to the new matter which the present edition contains. Two entirely new chapters have been added to the book; one on temporary trestles and methods of procedure in case of accidents, burnouts, washouts and other breaks in the track, and one on the renewal and replacing of trestles, giving descriptions of different methods of replacing trestles and some of the difficulties encountered. An entirely new section has been added giving examples of electric railway trestles, and additions and corrections have been made elsewhere throughout the book. The new chapters distinctly improve the book and make it more than ever the best treatise in print, probably, on the subject to which it is devoted.



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The question of covering slow sand water filters is reviewed in detail elsewhere in this issue in an article which we reprint from a report made recently by Mr. Allen Hazen to the water board of Trenton, N. J. The accumulation of a fair amount of additional data in the past six years has confirmed the earlier opinion advanced by Mr. Hazen to the effect that, so far as the low temperatures are concerned, filters need not be covered, ordinarily, where the normal January temperatures are 32° F., and above. The details on which this renewed conclusion are based, and other considerations bearing on the covering of filters, will be found in the article named.

The unfortunate occurrence at Mobile, Ala., where Captain King, of the Quartermaster's Dept., U. S. A., was caught receiving money from a contractor who was doing work under him, can probably be set down to the sudden expansion of the Army during the Spanish War. The accused officer entered the army as a volunteer at that time, when there was little opportunity to sift applicants, and when not a few obtained places through political backing. According to the newspaper reports, Capt. King deliberately blackmailed the contractor, condemning sound material and then offering to make the inspection more lenient for a consideration.

Whatever may be said of the West Point training and the long course of duty in minor positions that has to be gone through before positions of large executive responsibility are reached in the regular army, it certainly has the effect of training a set of men of notable personal and professional integrity. The instances are so few where men of this class have betrayed the trust reposed in them that they are the more remarkable when they do occur.

An excellent illustration of the public confidence in the officers of the Corps of Engineers is furnished by the growth of the River and Harbor appropriations. There are plenty who say that many of the projects on which the Government money is spent are not justified by commercial necessities present or prospective; but no one has opposed the River and Harbor bills on the ground that the money when appropriated would not be honestly spent. Were the case otherwise—were such occurrences as the Savanah Harbor frauds or this one at Mobile to become frequent, we may be sure that the annual River and Harbor bill would receive strong opposition on other grounds than those at present brought forward.

It is of interest to note that the Corps of Engineers controls a larger number of employees and disburses a larger amount of money than any other Government bureau. A recent review in the New York "Tribune" of the growth of the staff departments of the army gave the total number of employees under direction of the Corps of Engineers July 1, 1899, as 10,223. This does not include the officers themselves, 126 in number, nor the clerks and others employed by the Department at Washington, some 80 in all, nor the employees of the Missouri and Mississippi River Commissions, amounting to nearly 600. The moral which the "Tribune" article was apparently intended to point was the growth of the staff departments of the army at the expense of the line; but it ought also to have been stated in fairness that nearly al this force is engaged on purely civilian works. It may be added that notwithstanding the seemingly large total number of employees, the engineers in the list, including both the engineer officers and their civilian assistants of all grades, number all told only about 300. Further, it is a fact that this engineering work, especially in the higher grades, is done at very meager rates of compensation. We venture to say that there is no private employer of engineers in the country that gets so much good engineering work done for so little money as does the Government on its River and Harbor improvements.

It is the more credit, therefore, to the Corps of Engineer officers and to their civilian aids that their record shows so very few departures from the course of honor and honesty. It has been said —and there is much truth in it—that to create a body of public officials who will be faithful to their trusts under all circumstances, it is necessary first of all to pay them a compensation large enough to supply their reasonable needs, so that they may be delivered from petty temptations; and large enough, too, for them to feel that the Government which they serve is treating them fairly. There is much truth—as we have said—in this position, and yet here is a body of public officials which has long rendered loyal and faithful service for inadequate compensation; they, at least, deserve the credit of their professional brethren for the high standard they have maintained.

The projects for equipping the engineering profession with a code of ethics and other paraphernalia of the older professions have apparently been abandoned in this country, although across the border, the Canadian engineers are still pursuing their plans to secure legislation which shall make engineering a "close profession." While engineers in the United States have apparently dropped the matter, the architects are continuing their efforts toward a stricter organization. In Illinois a law was secured three years ago requiring a license for the practice of architecture and establishing a state board of examiners to grant such licenses. An effort is to be made to secure similar legislation in New York at the present session of the legislature. Perhaps the most notable thing of recent date, however, in this field is the action of the American Institute of Architects, made public at its recent conventions, in disciplining two of its most prominent members, Mr. Henry Ives Cobb of Chicago, and the firm of Harding & Gooch of New York. Both these cases were a result of the unfortunate competition in the preparation of designs for the Pennsylvania capitol a couple of years ago. The Board of Directors of the Institute censured Mr. Cobb for taking part in the second competition for this work, the Board holding that this second competition was unauthorized and illegal. The New York firm was "severely censured" for their action in protesting against the result of the first competition and attempting to nullify it after they had taken part in it and agreed to its terms.

That the Institute should undertake to discipline members of such prominence is the more remarkable in view of the fact that the Institute includes only a small fraction of the architects of the country, the total membership being only a little over 500. It has set a high standard, however, and evidently holds to the sound rule that an organization which is competent to exact certain standards for the admission of members is competent also to investigate and punish infractions of such standards by its members after their admission.

It is noteworthy that the punishment awarded was not expulsion or suspension from membership, but formal censure; and this, too, seems a wise choice. It cannot be said that the acts complained of were such as to show the unfitness of the men to be members of the Institute; yet it appeared desirable to express formal disapproval of acts which transgressed the Code of Rules adopted by the Society to govern competitions. It is worth consideration whether occasional action by engineering societies upon matters of professional misconduct might not have a salutary influence in establishing standards and inducing adherence to them.

The speedy passage of the Senate bill, calling for the establishment of a national standardizing bureau, is to be urged in the interest of the further development of American industries, and for American success in the industrial warfare for the world's commerce now being waged among the chief nations of the world. That we have not had a well-equipped bureau of this character long ago is a national reproach, and shows little appreciation of the ability and experience of our own scientists and the demands of our manufacturers. As a manufacturing nation the United States has passed the stage where it can depend alone for success upon a wealth of natural resources and upon common intelligence in methods of manufacture. We are now in direct industrial competition with nations that in some respects are better equipped than ourselves; and this is especially true in the use of the latest scientific development in technical methods and the exact study of methods by means of carefully established standards and measurements. It is by this exact comparison that economies are measured and methods are improved upon.

Our own scientists, investigators and manufacturers recognize these economies and the value of standards in comparing methods and turning out exact work. But for the standards themselves, all of these men are practically dependent upon our chief trade rival—Germany. Strange to say, the only American standard legally recognized by Congressional action is the troy pound of the Mint, fixed about 1827. And it is absurd to realize that while we have a law regarding electrical standards, we have no means of carrying out this law; and we cannot enforce it simply because there are no legally recognized electrical standards in this country, and there is no place in the United States where such standards could be compared even if fixed by law. In the case of our own government, an incident was brought up before the Senate subcommittee having this bill in charge, where when the U. S. Navy Department wished to purchase a large number of electric lights, it was forced to send some of these lamps to Germany for test before a standard could be adopted for the acceptance of the lot. American makers of meters and machines or apparatus for exact measurement, must also depend upon foreign governments for the means of graduating their own products; and in ways without number our government and our industries demand a radical change from present American practice in about all that relates to standards, and means of test of materials, machines and products.

Germany recognized the value of such an insti-

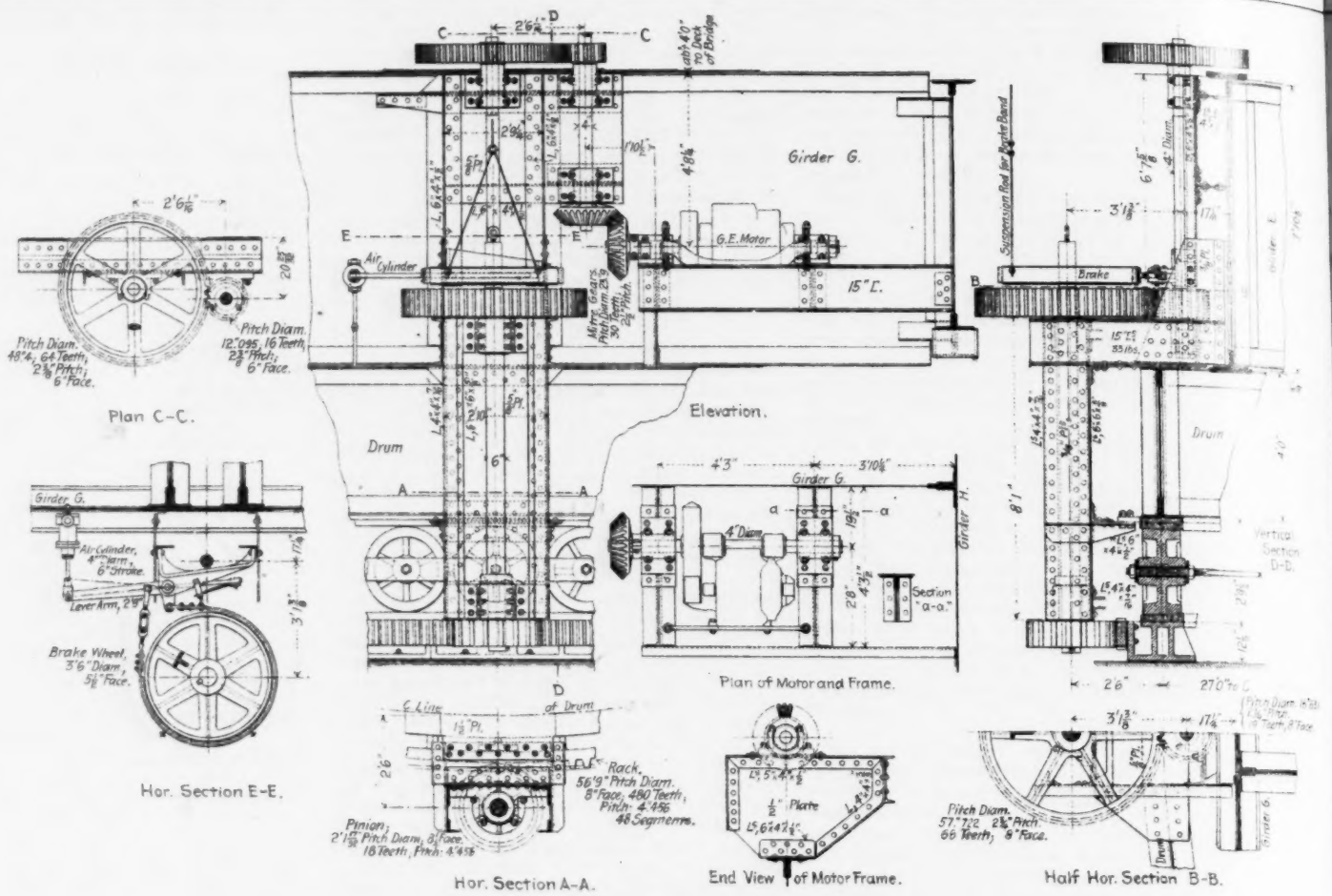

Girder G.
G.E. Motor
Air Cylinder
15" C.
Drum
Brake
Suspension Rod for Brake Band
Plan C-C.
Pitch Diam. 48"4; 64 Teeth; 2⅜" Pitch; 6" Face.
Pitch Diam. 12"095, 16 Teeth, 2⅜" Pitch; 6" Face.
Elevation.
Hor. Section E-E.
Air Cylinder, 4" Diam., 6" Stroke.
Lever Arm, 2'9"
Brake Wheel, 3'6" Diam., 5½" Face.
Plan of Motor and Frame.
Girder H.
Section "a-a."
Hor. Section A-A.
C. Line of Drum
Rack. 56'9" Pitch Diam. 8" Face; 480 Teeth; Pitch: 4.456 48 Segments.
Pinion; 2'1.55" Pitch Diam. 8" Face. 18 Teeth; Pitch: 4.455
End View of Motor Frame.
Plate
Half Hor. Section B-B.
Vertical Section D-D.
Pitch Diam. 57"722 2⅜" Pitch 66 Teeth; 8" Face.

FIG 4. DETAILS OF TURNING MACHINERY.

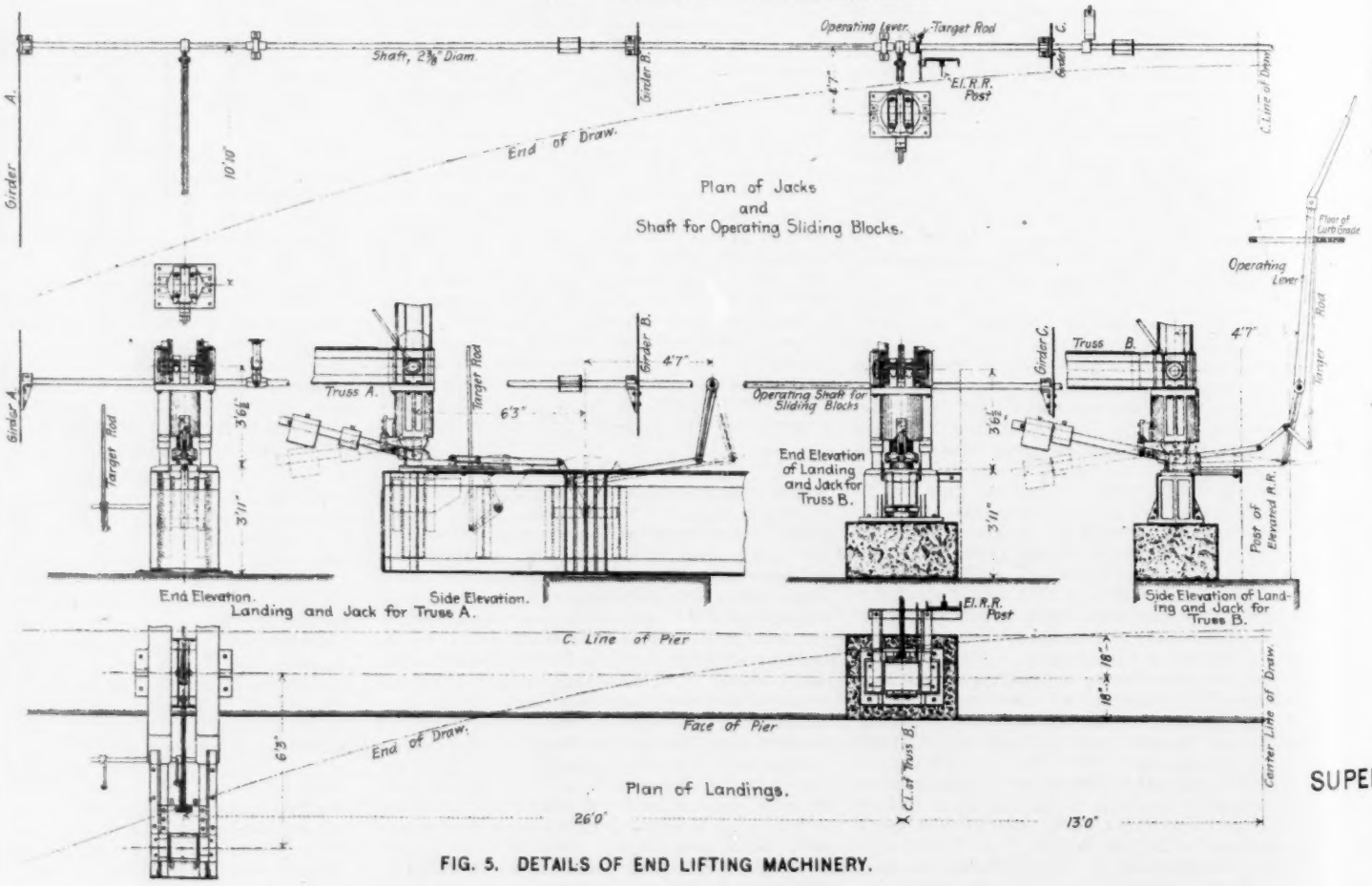
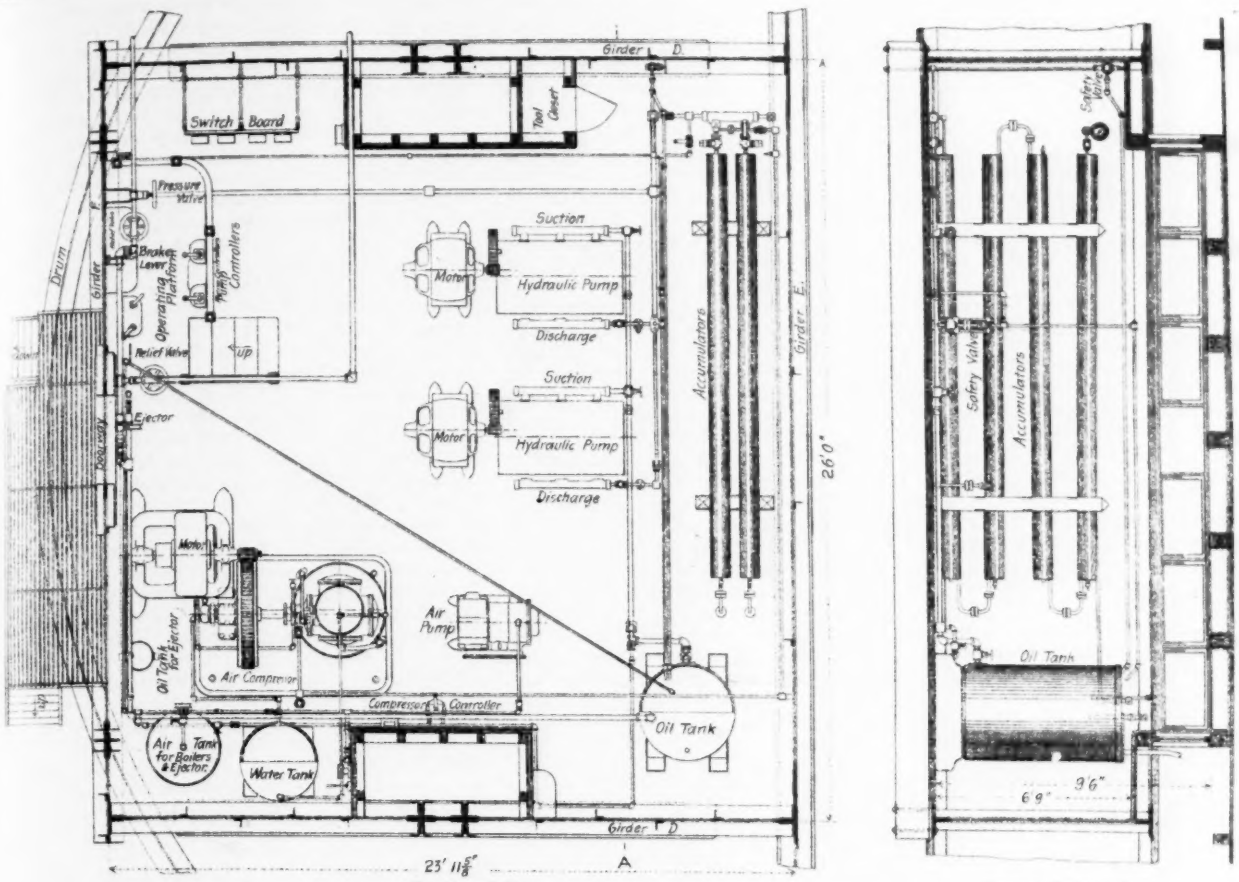


FIG. 5. DETAILS OF END LIFTING MACHINERY.

SUPERSTRUCT

Willian



Sectional Plan.

Vertical Section A-A

FIG. 6. PLAN AND SECTION OF POWER HOUSE MACHINERY.

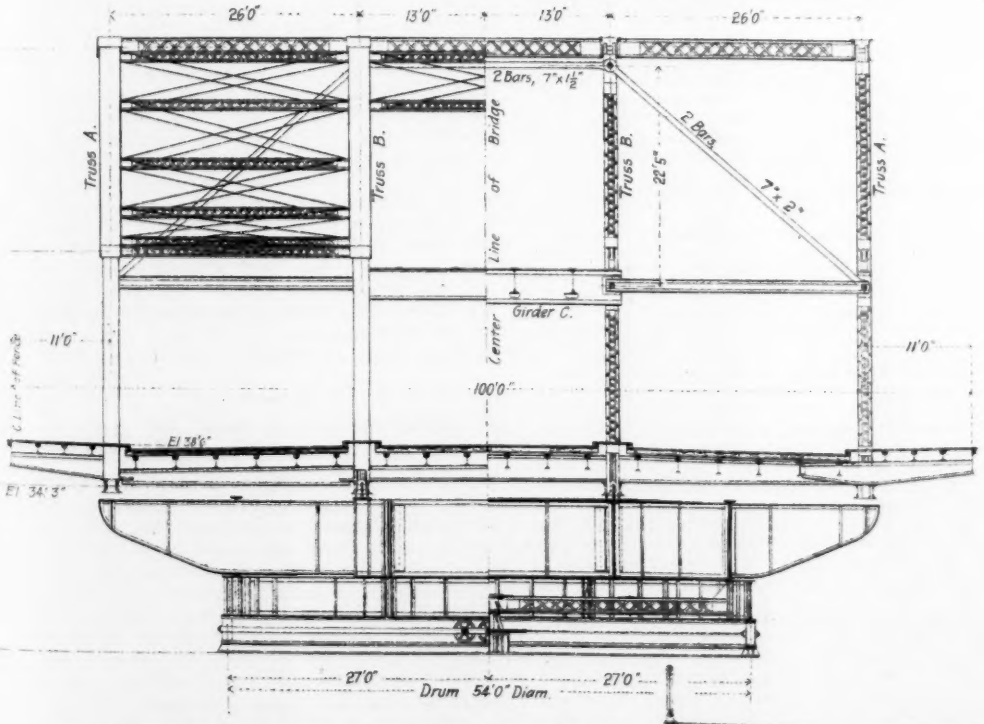


FIG. 3. TRANSVERSE SECTION THROUGH SWING SPAN.

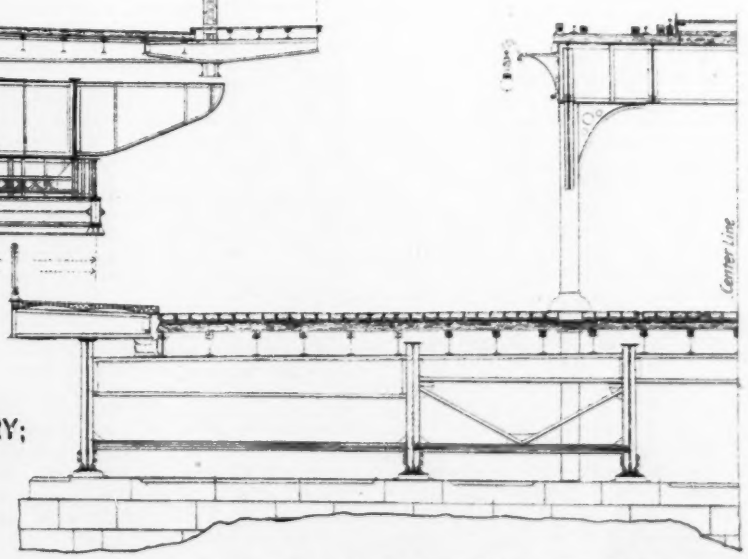


FIG. 2. TRANSVERSE SECTIONS THROUGH FIXED SPANS.

SUPERSTRUCTURE AND SWING SPAN OPERATING MACHINERY; CHARLESTOWN BRIDGE.

William Jackson, M. Am. Soc. C. E., Chief Engineer.

CHAS. HART, LITH., 26 VESEY ST., N. Y.

tution as long ago as 1868; and in 1887 she established Die Physikaliche Technishe Riechenstalt, or a national physical laboratory and standardizing bureau, upon which $1,000,000 has been expended in buildings and equipment, and for which $80,000 is appropriated annually. This German institution, while not quite so broad in its scope as the proposed American bureau, has a purpose that is of national importance and one that tends to promote scientific and industrial advance. And its value is well shown in the acknowledged commercial growth of Germany in recent years. This German laboratory is equipped to take up such physical investigation and measurements, in the solution of important scientific problems, as may involve the expenditure of more time, equipment, material and money than a single educational institution or industrial establishment could afford. It also makes such physical or technical investigation as the government may call for; or such as would promote the interests of manufacturers of instruments of precision used in connection with German industries. It verifies and calibrates measuring instruments and standards of reference; and in special cases it makes for German manufacturers instruments or parts of instruments too costly to be produced in private workshops. In return for this public service, the bureau only asks the cost of the material, plus the value of twice the time consumed in construction.

England has four establishments, more or less devoted to standardizing. And in 1899 this nation established a National Physical Laboratory, at Richmond, which is to absorb the present income of some of the others, and is to be fitted for original physical research work. Austria and Russia both have bureaus modelled somewhat upon the German Reichenstalt, but less fully equipped and less liberally endowed.

The United States, in the position it holds among the nations of the world, offers an especially broad field for the work of such a bureau. In all else we are practically free of foreign methods and practice; and if our traditions are of any value as an index of the future, it is safe to say that with such a bureau once established in this country, and fostered by a wise and liberal legislative policy, but a short time would elapse before American standards would have world-wide recognition. Our machine tools and their products now depend for their excellence and recognized wonderful sameness of output upon the use of the most exact standards of construction. If we have reached this measure of success with standards borrowed from across the sea, what could we not do with our own under the development of standards and methods which would naturally follow a national recognition of the extreme value of such standards as applied to all industries?

BACTERIAL TREATMENT OF LONDON SEWAGE AND AMERICAN SEWAGE DISPOSAL PROBLEMS.

The caution with which engineers and municipal officials should venture upon the rapid filtration of sewage by means of bacterial contact beds, of which so much has been heard of late in England and America, is emphasized by the latest published conclusions relating to the London experiments.* Dr. A. C. Houston, who has been responsible for the bacterial studies pertaining to the experiments, sums up his biological conclusions, after "two years close study," as follows:

> In view of these results, only one conclusion seems possible, namely, that however satisfactory the process may be from the chemical and practical point of view (note the last phrase—Ed.), *the effluents from the bacterial beds cannot be reasonably assumed to be more safe in their possible relation to disease than raw sewage slightly diluted, but otherwise unaltered in its bacterial composition.*

This sentence, as shown by the qualifying phrase just before the portion in italics, is not to be taken as condemning the bacterial contact beds, but merely as emphasizing their limitations under conditions similar to those prevailing in the London experiments. It means that the experimental processes applied there cannot be expected to make drinking water from sewage, or to lessen materially, if at all, the immediate danger of turning such bacterially-treated sewage into drinking water. The most that could be said for this sort of effluent, in its relation to drinking water, although not mentioned in the report, is that the reduction of organic matter which it has undergone has deprived the liquid of some of its possible support for bacterial life, so the subsequent diminution in numbers of contained bacteria might be expected to be more rapid than in the case of crude sewage. Dr. Houston's conclusion has all the more force because it is based on qualitative as well as quantitative studies of the crude sewage and the various effluents.

As Dr. Houston says, the bacterial results must be placed side by side with the chemical, if the process is to be rightly judged. After that has been done, or while doing it, the nature, extent and uses of the water into which the effluent is to be discharged must be given due consideration. This is as true of other disposal works as those at London. The situation at London, and the reasons why bacterial results may be ignored there, so long as chemical results are satisfactory, are stated with clearness by Dr. Houston, while at the same time indicating the chemical and bacterial purification effected, in the following paragraphs:

> The Thames is a tidal river, and the "intakes" for water-works purposes are situated high up the river and are "cut off" by "locks" from the influence of the sewage discharge at the Outfall Works.
>
> Although the bulk of London sewage is certainly very great the large size of the river Thames must also be considered, as also the proximity of the "Outfalls" to the sea and the huge body of water in the river at high tide.
>
> The river water outside the influence of the discharges at the Outfall Works is already polluted and contains practically all the bacteria found in raw sewage.
>
> The body of Thames water which may be supposed to be directly affected by the discharge of the effluents at Barking and Crossness is "brackish" and so could hardly be tolerated for drinking purposes even by individuals who are indifferent to the physical characters and biological composition of the water which they drink.
>
> The bacterial coke-beds effect a reduction of at least 50, and it may be as much as 80% in the amount of dissolved oxidizable and putrescible organic matter in the raw sewage, as compared with 17% effected by the chemical treatment.
>
> The effluents from the coke-beds are apparently non-putrescible.
>
> The suspended matters in the crude sewage are practically entirely removed as a result of the biological treatment, instead of only about 80% effected by the chemical treatment. And recent experiments seem to show that this result may be obtained without loss of capacity in the coke-beds if the sewage has undergone a previous process of rapid sedimentation.
>
> In the biological treatment no chemicals are required, and no offensive sludge is produced.
>
> Where an effluent is turned into a stream to be used for drinking purposes, the bacteriological results are manifestly of more importance than the chemical; but when, as in the present case, the river is not a potable one, and is already polluted, the converse probably holds good; i. e., the chemical state of the effluent is of primary, and the biological of secondary importance. In the first case the chief object is to guard against disease, and in the second case the main consideration is to avoid fouling the river with putrescible matters to such an extent as to constitute a grave public nuisance.
>
> However desirable it may be to obtain an effluent chemically pure, and, at the same time, bacteriologically above suspicion of danger, a process which leads to the solution of the great mass of suspended matters in the raw sewage, which effects a striking reduction in the amount of putrescible matters, which avoids the use of chemicals and the accumulation of offensive sludge, which yields an apparently non-putrescible effluent, and which is at the same time practicable, is one which presents such singular advantages over chemical treatment, and which produces such satisfactory results in view of all the requirements of the case, that it would be idle to deny its value or attempt to minimize its usefulness simply because it falls short of a standard of absolute perfection.

The last two paragraphs of this quotation are worth as many lengthy volumes of detailed discussion on the ends to be aimed at in the treatment of sewage. The discharge of an effluent into water used for drinking purposes, unless at some comparatively remote point, is a questionable procedure at best. It certainly would be well for the community drinking the water of that stream to subject it to the most thorough purification, a practice which is commonly adopted abroad for all surface waters, and is bound to come into vogue here, as stream pollution and popular intelligence increase.

Are we to conclude from the London experiments that the new bacterial contact filtration processes of treating sewage will not produce an effluent suitable to be discharged into a stream used below for drinking purposes? So far as the distinguishing features of those processes is great rapidity, or small filtering areas, probably the answer is, yes, and that resort must be had to something approaching more nearly to intermittent filtration, along the older lines and slower rates. Of course, the number of contacts, or sets of filter beds acting in succession, and also the fineness of the filtering material in each set, may be increased, but this means a corresponding diminution in the rate of filtration, when the aggregate area is considered.

So far as we now remember, no extended and reliable data have been presented for any of the rapid bacterial systems showing that they, alone, will effect anything like the degree of bacterial purification attained by some of the best municipal intermittent filtration areas in Massachusetts. A few bacterial results may have been presented that ranged pretty well up the scale of bacterial percentages, but to put such effluents on anything like a potable water basis would require extensive additional filtration areas. It may be answered that no one wants to achieve so high a degree of bacterial purification. Generally speaking, this is very true, but we believe some laymen, at least, have been led to believe that it is possible, if not desirable.

What the rapid bacterial filtration processes bid fair to do is to largely, if not wholly, replace chemical precipitation, to eliminate or greatly reduce the sludge problem, and to increase the rate of filtration, or, what is the same thing, diminish the area of land required for filter beds, of whatever sort. This is much to be thankful for.

There remain some unanswered questions, which are made particularly emphatic by this latest London report. The chief of these is, to what extent are the rapid contact filter beds going to be reduced in working capacity, or thrown temporarily out of service, by a gradual clogging of the filtering material, thus lessening the interstitial or storage space for sewage within the beds? In some instances this reduction was from 0.5 to 1 per cent. a week, at London. It is also to be borne in mind that the London experiments, promising as they are, had extended over only some two years, at the date of the last report, and that the methods employed were changed several times during that period, particularly by varying the depth of filtering material, or altering the character of the applied sewage. Perhaps most of these changes might be considered as unfavorable to the working of the beds, but some of them were decidedly favorable, such as the substitution of partially settled for crude sewage. But the principal point in mind is that because of these changes many of the variations in practice were of comparatively short duration, so the conclusions must be judged accordingly.

It may be stated, before closing, that the filtering material employed in the small beds, or tanks, was coke of relatively large-sized particles, even in the finer, secondary beds, except that there was one set of tanks containing broken stone; that the depth of filtering material in the different tanks, or the same tanks at different times, was 5, 10 and 13 ft., respectively; that there was a coke bed a little over an acre in area, first having 3 ft. of coke breeze, to which 3 ft. of coarse coke was subsequently added; and that the practice was to fill the beds, let them stand full for some two hours, then drain them, the fillings ranging from one to four times in 24 hours. Some of the sewage treated was applied to the beds just as it came from the outfall sewer, except for rough screening; some of it, later on, was settled for longer or shorter periods, and some of it was the regular effluent from the chemical precipitation works. The results with sewage which had been subjected to a brief period of sedimentation, as

*Bacterial Treatment of Crude Sewage. Third Report by Dr. Clowes and Dr. Houston. Experimental Intermittent Treatment of London Crude Sewage in the Coke-Beds at Barking and Crossness. Presented by Prof. Frank Clowes, Chief Chemist to the London County Council, May 24, 1900 (with an Appendix to July 28, 1900). An article based on the second report, and describing the nature of these experiments, was published in Engineering News of Nov. 9, 1899.

compared with chemical precipitation, are considered so promising by Prof. Frank Clowes Chemist to the London County Council, that he has the following to say:

It seems reasonable that the experimental treatment of sewage by rough screening, followed by rapid sedimentation without the previous introduction of chemicals, might now be attempted on a larger scale, and that by this means an effluent of much greater purity than that at present discharged (from chemical precipitation works.—Ed.) might be sent into the river.

In conclusion, it must not be forgotten that the proposition at London is simply the substitution of one partial process of sewage purification for another, and that the effluent is discharged into a large volume of brackish and highly-polluted water.

LETTERS TO THE EDITOR.

Three Questions Respecting Bridge Practice.

Sir: I should like to suggest three questions in bridge practice for discussion, and in order to bring out replies I will take a stand on each of them. All of them have come up in my practice, but the authorities I have consulted seem to answer them in dogmatic statements instead of giving any grounds for their conclusions.

(1) Are straight twist-drills better than tapered reamers for reaming work after assembling?

It is not clear to me why some engineers require work to be reamed with straight twist-drills. Where a straight drill is used, the outside hole will guide the drill through the entire thickness of metal. If this hole is badly located and not in the average position of all the holes, the reamed hole may not be much better than a punched hole (Fig. 1).

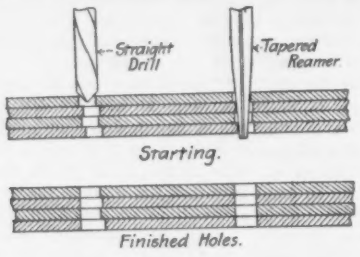


Fig. 1.

If a tapered reamer is used, the reamer will seek the average position of the holes, cutting away the most metal in each hole on the side toward this average position, thus leaving a straight round hole with no recesses, except where punched holes are very badly located.

Some time ago I inspected some girders made of I-beams and plates. The holes were reamed with straight twist-drills, and I had great difficulty in securing tight rivets on account of the fact that the holes in the cover plates did not match those in the beams well enough to give a straight round hole when thus reamed.

(2) Should the bearing of abutting sections of a pin-connected top chord with broken joints be relied upon?

It is much easier to pack a top chord joint where thick bearing plates are left out of the question, and there is an element of safety even in a joint where the bearing on the pin is several times the safe value, since the metal around the pin might crush, and still the ends of the members could take the load. The first is no argument, and the second is a confession of reprehensible practice.

Assuming faultless shop work and a fit as good as could be made, there is still an element of uncertainty about the efficiency of such a joint. The bored pin hole is usually quite smoothly finished, sometimes resembling a polish, while the end of a planed member is often like a coarse file. It is not reasonable to assume that the planed surface and the bored surface can thus be in the same degree of contact.

Supposing the same degree of contact could be obtained in the entire end section of the member, there is still a weak point. It is absurd to rely upon the full stress of one cover plate passing into the other when they meet at an angle. The two forces, a and b, will have a component c (Fig. 2), which would simply turn the edges of the plate up and throw all of the stress into the remainder of the section. The same would apply to the horizontal legs of the angles of the members, thus leaving only a fraction of the section to be relied upon. This reasoning ought also to be applied to all bent plates that take any considerable stress.

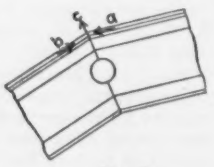


Fig. 2.

But the question of what is practicable in a bridge shop should be considered in all such cases. I have found it very difficult to get straight columns milled square enough to stand vertical when placed one above another in a building. When drawn into vertical positions large gaps are sometimes left at one or more of the corners. When it comes to milling a chord section perfectly square in one direction, exactly on an odd bevel in the other direction, and having exactly half a hole in the end, the difficulty is greatly increased.

As another matter of practice, in erection, I recently examined two bridges designed this way and found a number of points where the parts of the web coming below the pin were not opposite each other, in spite of the fact that the one pin plate was riveted to both webs. The paint and dizzy height prevented me from ascertaining how close the milled joints fit together, but I found one corner where the members were separated over 1-16-in.

When a practice, which seems to have crept into bridge designing through failure to apprehend its consequences, gives such results as these, it is time, in my opinion, that it be prohibited.

(3) Is the principle laid down in Johnson's "Framed Structures," paragraph 291, for splicing girder flanges, a correct one?

I put the question in this way because it would be quite long to put it otherwise, and I refer to Professor Johnson's book because it is a standard work. Some years ago I criticised this paragraph as it appeared in the 1893 edition. The text and figure are different in the 1895 edition, but, in my opinion, still contain in substance the same error.

The inference naturally taken from this paragraph is that several parts of a girder flange, each of area m, could be spliced by a plate of area m and two angles that together equal m; when the rivets in the splicing pieces between the successive cuts are also equivalent to m. As a general principle this is not correct, and, though the example given in the paragraph referred to has enough rivets, a slight change in the conditions, applying the same principle, would give a weak splice. A change in the order of the pieces spliced, for this same girder, would also give a splice deficient in rivets. In checking the details of a plate girder recently I found just such a splice; applying this principle it would seem to be correct, but analysis showed it to be deficient in strength.

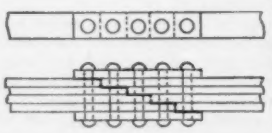


Fig. 3.

To simplify the case, suppose only the cover plates are to be spliced. Or suppose a number of flat bars are to be spliced, as shown in Fig. 3. Let the area of each bar and of each splice bar be a, and let this area require one rivet in double shear to take its stress. We have now a case that fulfils all the essential conditions of the case above cited. The four bars would require eight rivets in single shear, but if the above should fail on the heavy line only five rivets would have to be sheared. The splice is therefore five-eighths as strong as it should be.

Very truly,

Edward Godfrey.

Western University of Pennsylvania,
Allegheny, Pa., Jan. 2, 1901.

Deterioration of the Peoria Stand-Pipes.

Sir: In the "Street Railway Journal" of Dec. 1, 1900, there appeared an article by Mr. Albert B. Herrick purporting to be a review of a paper on "Electrolysis of Underground Metal Structures," read by me before the American Water-Works Association in May, 1900, and largely reprinted in Engineering News of July 19, 1900. I received no copy of the article either from the editor of the "Street Railway Journal" or from Mr. Herrick, and did not see it until too late to reply in the January number of that periodical.

The article is chiefly notable for its misstatements.

The pittings in the Peoria stand-pipes were cited only as instances of electrolytic action in a district where the mains were negative to the rails, and those who have at heart the preservation of valuable property constantly exposed to serious danger from vagrant currents should not allow the discussion of a particular case to befog their minds, nor to draw away their attention from the far more important general subject of a practical remedy for a serious and most unnecessary evil.

Mr. Herrick's first statement, that in the writer's paper "an attempt was made to show that the collapse of the stand-pipe at Peoria, Ill., was due to electrolysis, caused by street railway currents," is incorrect. The writer's paper expressed absolutely no opinion as to the cause of the failure of that stand-pipe.

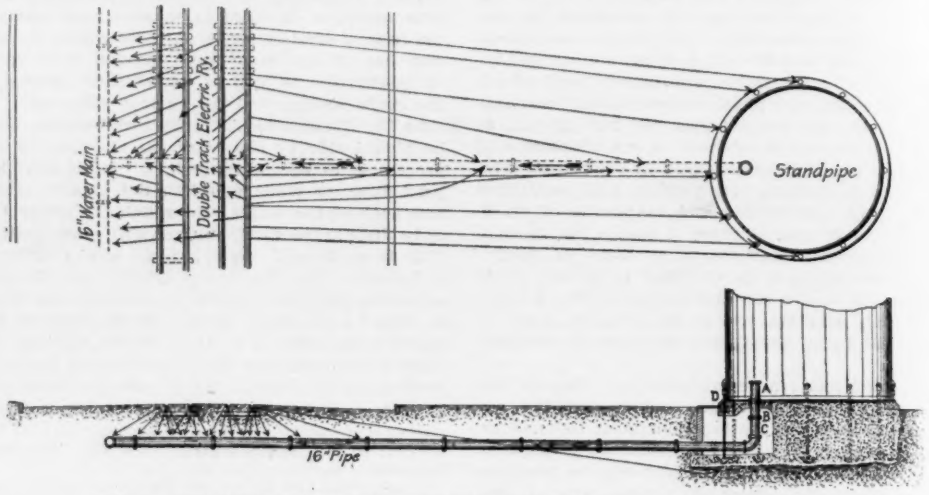


FIG. 1.—MR. HERRICK'S "CORRECT DIAGRAM OF CIRCUITS AT PEORIA."

That "this paper was later introduced as evidence in the test case for damages for the destruction of this stand-pipe between the Peoria Water Co. and the Central Railway Co. of Peoria," is without foundation. The suit against the Central Railway Co. is not for damages, but for relief by injunction, and the evidence in that case was closed nearly eight months before the writer's paper was first read at Richmond.

Mr. Herrick reproduces photographs of pits in the Raritan stand-pipes and cites an instance of pitting in the steel penstock used by the Merrimac Water Co. The fact that pits were found elsewhere which were not, as he claims, caused by electric railway currents does not, of course, prove that the Peoria pittings were not caused by such currents. Nor is there any proof produced to show that the pittings referred to by Mr. Herrick may not have been caused by stray currents from lighting plants. With the best intentions it is often found impracticable to prevent absolutely grounds in lighting circuits, and in the old days of defective insulation some grounds were the rule rather than the exception, and the writer himself has seen more than one instance of the intentional grounding of lighting wires on water pipes.

That pits said to be like those found on the Peoria stand-pipes are entirely different from the effect produced by ordinary corrosion is sufficiently proven by the fact mentioned by Mr. Herrick, that, when found, they were deemed worthy of note in the technical press. And that the water in Peoria has of itself no such pitting effect is shown by the fact that plates from the Peoria stand-pipes, immersed for years in that water under conditions as nearly as possible identical with those to which the stand-pipes were exposed, saving only that these plates were not subjected to stray street railway currents, showed no pitting, but simply uniform and gradual ordinary rust.

In Fig. 1 is reproduced a diagram which in Mr. Herrick's paper was marked "Fig. 8, Correct Diagram of Circuits at Peoria." And this diagram, in so far as it shows part of the current flowing into the anchor bolts and back again along the inlet pipe to the water main, is correct. It has not been claimed that all the current on the water main flowed first into the stand-pipe anchor bolts. To reach the mains the current had to follow all available paths, and most of it entered the main by the paths offering the least resistance. Whether those paths were the shortest cuts between rails and mains or were more circuitous routes would depend largely on the comparative moisture of the soil along the various paths, and the soil was always wet around the stand-pipes when they were in service.

As the mains were always negative to the rails in this neighborhood (differences of potential of 10 volts were found at this point), there was always a tendency for current to flow from every point of the rails to every point of the mains or of metal structures connected to them, and there was a drop of potential along the inlet pipe (called by Mr. Herrick "Equalizer") from the stand-pipe to the 16-in. water main, so that for Mr. Herrick to say that the current had to "flow against itself to and from the stand-pipe" is not only incorrect and misleading, but

also contradicts his own diagram reproduced in Fig. 1, above referred to.

Mr. Herrick further says: "Again, in order to sustain this theory of electrolysis, the current has to leave the pitted sides of the stand-pipe and reach the flange A in order to affect the internal sheets of the stand-pipe as claimed; it has also to pass through the water circuit instead of the metallic circuit formed by the iron bottom of the stand-pipe to which flange A is connected. The measured resistance of the metallic circuit, which shunts the water circuit, shows the relation of these two circuits to be over 890,000 to 1. In other words, the natural laws of electricity have to be distorted to account for the depreciation of this stand-pipe from electrolysis."

Immediately after the fall of the stand-pipe, and while the remaining one was still in service, Messrs. Stone and Webster conducted in Peoria most exhaustive electrical surveys, covering seven weeks on the ground, a large portion of which time was spent in study of the stand-

FIGS. 2 AND 3.—VIEWS SHOWING ELECTOLYTIC PITTING ON PIPES OF PEORIA WATER CO.

pipes. They reported that current did pass from the rails through the ground into the stand-pipe shell and out again by way of the water and inlet pipe, and that the pitting on the shell and on pipes A and B was accounted for by that current. This current varied with the movements of cars, and to such an extent that the position of cars could be approximately determined by the movements of the millivoltmeter needle alone. The writer personally assisted in these surveys, and, with Mr. Knudson, afterwards fully verified them.

Against the ascertained facts, Mr. Herrick sets up his marvelous "890,000 to 1." As he never saw either stand-pipe, he never could have measured the relative resistances of the metallic circuit and water circuit. And the fact that he has entirely ignored the resistance of the insulating joint between B and C, Fig. 3, which caused the current which had entered the shell, and pipes A and B, to leave them for the water in order to regain the inlet pipe beyond that joint, would render interesting a detailed explanation of the mathematical gymnastics by which he arrived at the figures quoted, and of the actual bearing on those figures on the case when arrived at.

Mr. Herrick's next paragraph reads as follows: "The pitting of A and B, and not C, can be readily accounted for by the fact that A and B, being part of the stand-pipe structure, were not of the same composition as pipe C, and were made by the stand-pipe manufacturers. This iron runs high in phosphorous and carbon, and it is well known that this composition is much more readily corroded by water than cast iron."

The truth is that the pipes A, B and C were of cast iron, and together with all the other flanged cast-iron pipes connected to the stand-pipe, were furnished by the same party. The stand-pipe was of steel. These facts make comment on the balance of the paragraph just quoted superfluous, unless Mr. Herrick wishes to convey the impression that "stand-pipe manufacturers" usually make their own rolled steel plates and cast-iron flanged pipes, and make both from the same mixtures and by the same processes; or that wrought iron and steel contain more carbon than cast iron.

I again quote Mr. Herrick: "It can be seen from the photographs, Fig. 5, that the top flange of A and the surface around the bolt holes are pitted. If the current did flow from the sides of the sheet to A, these surfaces should not have been pitted, according to Mr. Maury's statement."

The top flange of A, and the surface around the bolt holes, were not pitted. There was not a pit on the surface of either A or B except, as shown by the photograph, on the inside of those two pipes.

In Mr. Herrick's next paragraph he says: "Each of these bolts was measured with a potential of 500 volts to discover if by any conceivable means current to produce the pitting complained of could have been introduced into this stand-pipe" [he does not tell the result of these measurements, but goes on to say] "but if it had, it would not have taken the path indicated, etc."

Mr. A. A. Knudson and the writer are prepared to testify that, with only the pressure due to the voltage of the stray return railway currents, those currents did actually flow through those anchor bolts, and that in spite of the greatly improved conditions of the rail bonds, which had all been overhauled just prior to our measurements, in spite of the fact that, as the stand-pipe no longer existed, the soil was much dryer than when it was in service, and in spite of other changes in conditions, all of which tended to greatly reduce this current flow, the quantity of current was sufficient to cause serious ultimate electrolytic pittings.

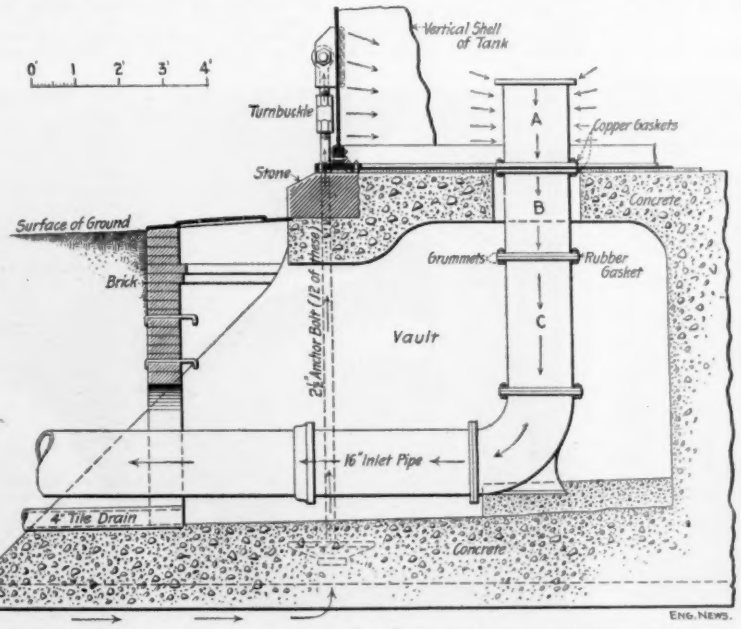


FIG. 4.—PARTIAL VERTICAL SECTION OF PEORIA STAND-PIPE, SHOWING COURSE OF ELECTRIC CURRENT.
Reproduced from Eng. News of July 19, 1900.

Turning from the stand-pipe to Mr. Herrick's next statement we read that: "It was further found, in connection with the electrolysis power station,* that the Peoria Water Co. had established a metallic connection between the water pipe system and the rail returns by locating its gate boxes directly against and electrically connected to the rails, thus forcing current into the water pipe system. The position of the rails in the streets is fixed by ordinance; the gate box location is at the option of the water company."

The truth is that out of the hundreds of gate boxes in the streets of Peoria there was not one which established either mechanical or electrical connection between the rails and the water piping system. Gate boxes are necessarily over, but are never set so as to rest upon the water mains. In Peoria nearly all were placed as required by the city ordinances years before the railway tracks were laid. But three of these boxes were ever in mechanical contact with the rails, and these only for an instant from the pressure of a passing car; none of them rested upon, or were ever in mechanical or electrical contact with the mains. Careful measurements made by Mr. Knudson and the writer showed that the total current passing into and out of 23 of these boxes which were nearest to the rails, did not exceed one-fourth of one ampere, an inappreciable fraction of the railway current carried by the water mains.

Only 39 of all the gate boxes were found to be within one foot of the street railway tracks in Peoria; every one of these was at once removed, and as the foregoing statement of the actual facts would indicate, their removal has made absolutely no measurable change in the conditions. Current continues to flow on the mains just as before, and the mains and service pipes are pitted in the same old way.

Within the last year the writer has never failed to find some evidences of electrolytic action on the mains in Peoria wherever their joints have been examined by him, no matter whether in the positive or negative district. The photographs, Figs. 2 and 3, show examples of pitting in 16-in. pipes which were removed in the spring of 1900. There were in all nearly 1,000 ft. of this pipe, which was about two miles from the power station, and ran off at right angles to the tracks. It was always negative to the rails, and the current flowed along it from the spigot end of one pipe into the bell end of the next. No pits could be found anywhere on this pipe except near the positive side of each joint, but the spigot end of every single pipe was pitted, either on the inside or outside or both, where the current left it.

These photographs furnish another striking instance of electrolytic pitting in the negative district, and show the danger to which an entire piping system is exposed when current is allowed to flow along the mains, a condition that cannot be avoided if the single trolley system is continued.

"The fear of danger" has not "nearly passed," as Mr. Herrick states. On the contrary, there have never been so many nor so serious complaints of injury as there are to-day. This fact is virtually recognized in the editorial on that subject in the same number of the "Street Railway Journal" which contains Mr. Herrick's article. The editor also incidentally furnishes one of the very best of arguments in favor of the double trolley when he says:

"It would be an interesting question as to how to trace any alleged damage in the case of several operating companies in the same city. If damage is found or if the water company thinks that it has found evidence of electrolysis, it would be a serious problem to proportion such damages between two or three railway companies which traverse the territory in which the pipes exist. It is not enough to prove that the injury was caused by a return circuit, but the particular amount of damage which each company caused would have to be shown in order to collect damages."

*Presumably there was a stenographic error here, and that the word "question" was intended, where the words "power station" were written. D. H. M.

This statement coming from the editor of the "Street Railway Journal" gives peculiar emphasis to the futility of damage suits. Even where all the lines in any city are operated by one company, it would cost almost as much to dig up the pipes and prove all the damage which had occurred as it would to renew the piping system. The only way to remedy the evil is to remove its cause.

If it could be shown in court that the present system of conveying water through pipes was defective and dangerous; that the fluid conveyed leaked out at every joint, or that the pipes actually burst, interfering with traffic, destroying pavements, injuring street car tracks, endangering the foundations of neighboring buildings, or depriving business districts of fire protection until the breaks could be repaired, and if it could be further shown that by the adoption of some other system of conveying this fluid the owners of water-works plants could not only stop all this injury and danger, relief from which could be had in no other known way, but that they could thereafter conduct their business at least as economically and profitably as before, no one will doubt that the court would order the pipe owners to adopt the safer system.

The analogy between this supposititious case of the pipe owners and the actual case of the railway companies seems to be complete in every respect. The current conveyed by the grounded returns of single trolley systems does, in obedience to the laws of fluid flow, leak off at every point of those returns at which the temptation presents itself, and this leakage, by injuring the water pipes, must inevitably result in exactly the above described injury and danger to the property of others.

That there is no known method by which owners of water and gas pipes can themselves prevent injury to their property from single trolley currents is now admitted by every engineer of competent experience and knowledge of the subject of electrolysis.

The fact brought out by Mr. Herrick that the company owning the greater number of lines in the District of Columbia, voluntarily makes the expenditure for double trolley on lines which it finds necessary to rebuild, even when extending far beyond the District limits, in advance of their actual operation under anticipated legislation, is not a weighty argument against the practical success and early adoption of the double trolley.

The decision of Judge Carter, of the Superior Court of Indiana, published in part in Engineering News of Jan. 3, has an important bearing on this whole question.

Peoria, Ill., Jan. 9, 1901. Dabney H. Maury.

Sir: I have read Mr. Maury's letter and I had previously read Mr. Herrick's paper in the "Street Railway Journal" of Dec. 1, 1900, entitled "Deterioration of the Peoria Stand-pipe," to which Mr. Maury's article is a convincing reply.

Mr. Maury's references to the investigations which we together conducted in Peoria at the site of the stand-pipes and in connection with the gate boxes and to the general electrolytic conditions in that city are absolutely correct.

Mr. Maury is one of the ablest and highest authorities in electrolytic investigation, although his work in that field has been but incidental to his general profession as an engineer. His statements call for no corroboration from me, but my personal knowledge of the matters referred to by him enables me to fully confirm what he has said.

Mr. Herrick's statement that "the fear of danger has already nearly passed" will make any one smile who knows anything about the subject. The increasing number of serious cases of electrolytic injury cannot be belittled in any such way. The fear of danger will not pass, and the destruction of water pipes will continue so long as the rails are used to return the current.

This is strikingly illustrated by recent developments in the city of Cambridge, Mass., where the conditions of track return have been considered ideal. Figs. 6 and 7 are taken from photographs furnished the writer by the Engineering Department of the Metropolitan Water Works, and show severe pitting by return railway currents in a 48-in. main in Cambridge, which has only been exposed to the current about 2½ years. Respectfully,

A. A. Knudson.

New York city, Jan. 10, 1901.

FIG. 5.—INTERIOR VIEW OF LENGTHS OF INLET TO STAND-PIPE, SHOWING PITTINGS IN A AND B, AND EFFECT OF INSULATION OF C.

DERAILMENTS AND CONCLUSIONS TO BE DRAWN THEREFROM.*

W. H. Elliott.†

While the subject of the derail has been so often discussed that the arguments both for and against the use of such a device have become threadbare, the opinion expressed by so many signal engineers at the St. Louis meeting, that a derail was not needed and the results sought for were to be obtained by better discipline, would lead one to suppose, that with the signalmen at least this method was gaining in favor, while the enforcement of obedience to the indication of the signal that is given by the derail was believed to result in more damage and delay to trains than if the derail were not used.

In the discussions that have taken place, no figures have been presented on one side or the other, the arguments being based for the greater part on certain bad accidents or derailments that had occurred. That collisions will happen without the derail and that derailments will occur when no collision would have resulted if the derail had not been used, only makes it all the more desirable that the practice followed will give the best results.

The American Railway Association has placed derails among the "adjuncts" instead of among the "requisites of installation," thereby making it optional, with each road, if the association be taken as authority, whether the derail shall be used or not. This was necessary if the derail was to be mentioned in any way, since there are so many interlocking plants in use that a change to meet any practice the association might recommend would be too expensive for those roads which did not use derails, and a departure for those who did use them that they could not approve of.

The 141 derailments, which the record shows to have occurred from the time the record was commenced to that when this paper was written, have been grouped under the several causes of derailment with a view of showing whether the derail was of advantage or not. These are:

1. Train on crossing. Collison would very likely have happened	16
2. Drawbridge open, train would have gone in stream.	3
3. Train just passed off of the crossing but not out of interlocking at time of derailment	3
4. Signals set for an approaching train but not probable that a collison would have happened	11
5. No train on crossing. Derail open. Approaching train not seen by signalman	4
6. Engineman ran by signal. Reason why derail was open not ascertained	29
7. Engineman forgot about signal, did not shut off until derailed. Derail caught and could not be closed	1
8. One train following another closely took indication given to first train and was not able to stop when signal was taken away	1
9. Engineman went by light other than signal lamp	3
10. Train switching. Light collisions would probably have occurred in a few of the cases	42
11. Signal at clear improperly	3
12. Broken red glass	4
13. Mistaken hand signal	3
14. Signalman pulled wrong lever by mistake	5
15. Signalman took signal away to set up route for another train	6
16. Train parted. Signalman opening derail in front of rear section	2
17. Signalman gave hand signal to train on left-hand track against back-up dwarf signal. Signalman thought train was on right-hand track and that light in home signal, which was clear, had gone out. Crossing torn out	1
18. Cars blown by wind or rolled down grade and off derail	4
Total	141

In the majority of cases but little damage was done to rolling stock or apparatus, the following being the only derailments where the results amounted to very much, or where there was chance of a collision at the crossing. Under No. 1, several derailments would have resulted in much greater damage than actually occurred had the derails not been used

A.—One derailed train was running so fast that the en-

FIGS. 6 AND 7.—VIEWS SHOWING ELECTROLYTIC PITTING OF WATER PIPES AT CAMBRIDGE, MASS.

*Abstract of a paper read at the January meeting of the Railway Signaling Club.

†Signal Engineer; C., M. & St. P. Ry., West Milwaukee, Wis.

ine left the ties after rolling 200 ft. on the dirt; finally turned over, smashing in the tower. The train to which the signal had been given was running slowly and although the engine had passed the derail, it was flagged by towerman so that it stopped before reaching the crossing.

B.—In one instance, two through passenger trains would have come together on the crossing although not running at high speed.

C.—In another, a through passenger train would have hit a local passenger train in two had not the latter been derailed, the train rolling to within 20 ft. of the crossing. The engineman was one of the most careful men on the road, but he misjudged the braking power of his train for the condition of the rail.

D.—A freight train on a down grade would have come into head-end collision with another train on a gauntleted bridge if the train running by the home signal had not been derailed.

E.—A freight train at a junction point would have run into the side of a passenger train if it had not been derailed.

Of the trains derailed at a drawbridge when the draw was open:

F.—One ran the length of the guard rail on the ties before taking to one side of the track, finally stopping on the bank with the front truck falling in the water.

G.—A train of 50 cars was derailed and rolled half way to the bridge before stopping.

H.—Of the derailments under fourth cause but one that was serious occurred, and in this a brakeman was killed and six or seven freight cars were broken up. The investigation brought out the fact that the engineman had lost his bearings and thought he was about two miles from the interlocking. The signalman had just set the signals for another train he knew was approaching but was not due for 5 minutes. Owing to a fog the headlight of the train derailed did not show to the signalman until the train was within a few feet of the home signal.

J.—Under the seventh cause the engineer of a passenger train, running at 40 miles per hour, forgot all about the signals and went off the derail with throttle wide open. The plant had been in service but three weeks. There was snow in the derail points and signalman was down trying to clean out the one on far side of crossing.

Of the derailments from signals at clear improperly:

K.—One was a distant signal which had been adjusted in hot weather by taking up all the slack in the down pull wire only. A fall in temperature shortened the wires pulling arm down; 8 cars off track.

L.—A broken stop on a dwarf signal allowing arm to go too far, showing clear light, caused another derailment. Engine off track.

Of the derailments on account of broken red glass, not one went off very badly, the trains happening to be running slowly at the time. In two instances the engineman could see the arm in stop position and had very nearly come to a stop.

Considered as a whole the facts show that very many more serious accidents would have occurred if the derail had not been used, and while there was a larger number of derailments with the derail than there would have been of accidents if no derail had been used, the damage to property and loss of life was so much smaller with the derail that it should be considered as a necessary safety device.

If the causes of derailment be considered, it will be seen that very strict discipline while probably reducing the number of derailments, the reductions, if any, would occur in larger proportion in cases where no derail was needed to prevent an accident than where an accident would have happened if the derail had not been used. To insure that no collision would result there must be no failure of the air brakes, no mistake in judgment or carelessness on the part of the trainmen or signalmen and no failure of the signals to give the proper indication. Look through the records of the railway service the world over and where will any road be found on which accidents from one or the other of these causes have not occurred. If they do occur, and that they do, can hardly be questioned, the expediency of using a derail resolves itself into a question of damage and delay to trains and the possible taking of life that will occur where a derail was used and where it was not. The record given above, while not covering as large a number of derailments as is to be desired, is yet sufficiently large to be used as an argument in considering the question.

On what roads will the best discipline be found? The roads in England have been spoken of in the club as being so free from accidents as to make the derail unnecessary, and yet, in the year 1898, two very serious collisions took place at as many different interlockings and resulted in great loss of life besides damage to rolling stock. In both cases the engineman expected to have the signals cleared by the time the train reached them, but one also made the claim that the brakes did not hold on account of a bad rail. Possibly there are fewer accidents at interlockings in England than in this country, but this, in view of the two spoken of may well be ascribed to the system of train blocking in use than to a matter of discipline. With the rule in force prescribed by the British Board of Trade, that where one train has been admitted to a block adjoining a junction point or crossing, trains on other approaches must be held on block away until the train admitted shall have passed 1,200 ft. beyond the point where a collision might occur there is little chance of one happening. Where this rule is lived up to, a derail is not necessary, but, as the results show, the rules are disregarded as well as the signals and accidents result that would have been of a much less serious character had a derail been used.

While the majority of interlocking crossings in the east may not be provided with derails, and accidents may be few or almost none at all, it can not be denied that they have happened, and serious ones at that. The one at Atlantic City did not occur so long ago, but that it can be taken as an example.

In what stage of human life will discipline be found to keep a man from making a mistake in judgment, or from having an apparently complete failure of his mental faculties? Discipline makes an engineer careful from fear of punishment whether that be in marks against his record or in being laid off, but does it give him greater experience and thereby help him in judging properly so as not to make mistakes. The engineman is more often mistaken in his judgment than is he careless, for with the knowledge that he will be derailed, a violation of the rule, to stop bringing punishment in the form of derailment, he must be unaware of the responsibility of his position to an extent that discipline would have but slight effect in preventing him from running by the signal if done through any fault of his own.

Will discipline prevent an engineman from running into an open draw after the usual stop has been made, for this has happened more than once. The knowledge that he would be discharged and might lose his life does not keep an engineman from running off into the river. Where two trains make a stop for a crossing and then run into each other, although in broad daylight and with nothing to prevent one from seeing the other, in what way would discipline be effective in preventing these men from getting together? To discharge a man is not more effective as a preventative than is the possibility of the man being injured or killed, and yet accidents from enginemen's mistakes are occurring with apparent frequency, as is shown by the accident reports to be found in the railway journals.

Discipline does not guard against the case of a man dying or getting killed on his engine. The engineman of a passenger train on a western road was killed a year or two ago, as the train was approaching a drawbridge over the Mississippi River. The draw was open and but for the bridge tender noticing that the train was coming on at higher speed than usual and hurried to get the draw closed the train would have gone off the abutment into the river. The fireman was putting in coal and had not noticed the engineman's condition until the train was almost on the bridge. Enginemen die suddenly at their posts from natural causes, and as this may happen while approaching an interlocking, the chance of finding the crossing clear is not so large that one would want to take it if they knew of the chance beforehand.

Should there be any more damage to property or greater danger to life by the use of the derail than there is without it, the argument in favor of strict discipline would bear more weight, but the facts show that there is less damage where the derail is used, and although one life was lost by the derailment reported, the fact that the train on the other track was not on the crossing was a condition that narrowly missed happening. Had the train been on the crossing one would hardly say it were better to let the two trains cut each other in two than to derail one of them, and yet, if it had not been for the mere accident of time the other train would have been run into. With the engineman of the derailed train believing that he was two miles away from the crossing it was not possible for him to have stopped the train had he tried on finding he was not so far away as he thought he was, and there would have been nothing else to have prevented a collision with a train on the crossing if the derail had not been in the track. The derail, if properly located, makes it very nearly a sure thing that two trains will not get together at a crossing, and leaves it, so far as the amount of the damage is concerned, very much a question of the surrounding conditions and the speed at which the train was going when derailed. If not far enough away to prevent the train from fouling the conflicting track, it would only show that the derail was not properly located, and not that a derail was not the best thing to depend on.

The conclusions to be drawn from statistics on derailments are given by Col. H. S. Haines, then Vice-President of the Plant System and President of the American Railway Association for a number of years, in a paper entitled "Railway Accidents, their Causes and Prevention," which was read by him before the Association. There conclusions are as follows:

A crossing collision should never occur. Either a crossing should be so protected by signals and derailing switches as to prevent the possibility of collision, or every train should come to an absolute stop at a post 50 ft. from the crossing. In that distance, a dangerous speed cannot be attained at the crossing, and when a collision does occur the engineman whose engine struck the other train should be held solely responsible.

THE SEWERAGE SYSTEM AND SEWAGE FARM OF THE MELBOURNE AND METROPOLITAN BOARD OF WORKS.

During the present decade, a metropolitan sewerage system has been constructed for Melbourne, Australia, and other cities and towns adjoining, on even more comprehensive lines than the work done for Boston and vicinity by the Metropolitan Sewerage Commission. The Massachusetts commission has dealt with only trunk sewers and the necessary pumping plants, employing disposal by dilution in salt water. The Melbourne and Metropolitan Board of Works has provided a complete collection and disposal system, including plumbing fixtures, waste and soil pipes, house connections, street laterals, trunk sewers, pumping plant, force mains and an immense sewage farm. In addition, the board operates the waterworks system which supplies the metropolitan district.

This great piece of sewerage work was described in a recent special illustrated edition of "The Building, Engineering and Mining Journal," of Melbourne, from which this article has been prepared. The description opens with a general review of the attempts to secure sewerage for Melbourne, prepared by Mr. E. G. FitzGibbon, chairman of the metropolitan board. Next comes a detailed account of the system, by Mr. Wm. Thwaites, M. Inst. C. E., Engineer-in-Chief. This is followed by two special papers on the tunneling, of which the board did about seven miles. These papers were read, not long ago, before the Victorian Institute of Civil Engineers, Mr. Henry V. Champion, Assoc. M. Inst. C. E., describing one particular piece of tunneling, while Mr. G. H. Dunlop, C. E., gave a comprehensive review of "Hydraulic Tunneling in Melbourne." Still another paper, on "Testing of Materials," is contributed by Mr. C. E. Oliver, M. Inst. C. E. This article is based chiefly on Mr. Thwaites' description of the work. Mr. Dunlop's paper on tunneling will be printed in a later issue of Engineering News.*

The Melbourne and Metropolitan Board of Works is composed of 40 members, each of whom, except the chairman, serves without pay, and is elected by and from the membership of the various municipal councils comprising the district. The president is elected by the other 39 members.

The area included in the sewerage scheme is about 103,000 acres, divided between 22 cities, towns and shires. The combined population in this area on Dec. 31, 1898, was 469,680, living in about 105,000 houses. The sewerage system is on the combined plan, no rain water being taken into the system permanently, with the exception of the drainage of 140 paved yards. It appears that the city of Melbourne has storm and subsoil water sewers, and that these are connected with the board's sanitary sewers, where feasible, the drainage being utilized to keep the sanitary sewers clean where the latter are first put in use. These connections are controlled by valves, which are closed at times of heavy rains.

The sanitary sewerage system is designed on the basis of an ultimate population of 1,000,000 and 30 cu. ft., or 225 U. S. gallons, per capita per day. The average water consumption in Melbourne is about 48 gallons per capita in winter and 108 gallons in summer, "so that the sewers are designed to run half-full if the whole of the water supply sent in to Melbourne on a hot day were again picked up without loss or evaporation, and discharged into the sewage farm."

The act creating the metropolitan district went into effect on July 1, 1891. Mr. Thwaites entered upon his duties as chief engineer on the same date, and to him were referred numerous plans for a sewerage system, previously made by Mr. James Mansergh, M. Inst. C. E., London, Eng. One of these plans was chosen, modified, and its execution begun, the date of starting work being May 19, 1892. On Feb. 5, 1898, the portion of the system designed to serve the center of Melbourne was put in operation.

As the work entrusted to the board included all the house plumbing and connections, it was doubly necessary to have a detailed survey of the whole district. This work was started in December, 1891, under 30 separate contracts, embracing 83,529 buildings in the more densely populated areas. The surveys were first plotted on 1,465 antiquarian sheets, on a scale of 40 ft. to the inch. The plans include existing storm water drains, water mains, valves and hydrants, gas mains, the levels of the lowest floor and of the cellar of each house and street levels at 100-ft.

*See Engineering News, July 18, 1895, for an account of a serious accident in the Yarra River tunnel, ahead of the hydraulic shield, and the same journal for Dec. 29, 1898, for an account of the Dunlop system of wooden tunnel lining.

intervals, as well as all physical features. Lithographed copies of these plans are used in laying out the lateral sewers. From the large scale plans district maps are compiled on a scale of 160 ft. to the inch, for use in designing the sewers of a district. For general records, the plans are photolithographed on a scale of 400 ft. to the inch.

Permanent survey and level points were established over the whole district by setting hollow tubular castings below the street level in a block of Portland cement concrete. Each tube is just large enough to receive a surveying rod, and is provided with a removable lid. For survey points, the pole is placed in the tube, and for leveling the rod is held on "the top of the internal hollow casting, giving a fixed bench mark."

All the framework points mentioned were fixed by the board, outside the contracts mentioned, the limit of error for lines being 3 ins. to the mile, and for angles, 15 degrees. Mr. E. A. Leonard had charge of all this work, with the title of superintendent surveyor.

Outside the contract area the board has undertaken to survey the remaining houses, numbering some 22,000, and has completed the field work for 9,000 and the plotting for 5,000. The total expenditure for these surveys, from December, 1891, to June 30, 1899, was nearly $300,000. Of the 92,000 houses surveyed, 39,000 are on the line of sewers. 23,992 had been connected, and 1,232 were being connected, in February, 1900. For a number of months prior to that date connections had been made at an average rate of 310 per week, or 16,120 per year.

Under an act passed in 1897, after the board declares that a property is sewered, or that a sewer is available for connections, the owner has three options: (1) He may submit a plan of the house plumbing and connection to the board for approval and do the work privately, within one month, or an extension of time granted by the board. (2) He may submit a plan to the board and obtain from it an estimate of the cost of having the work done publicly, after which the owner may do the work himself or request the board to do it. In the latter case, the board is bound to do the work and to accept the estimated price in settlement, regardless of the actual cost. Or (3), in default of action by the owner, the board may initiate and do the work, in which case the owner has the privilege of paying for it in 40 quarterly instalments, with 5% interest on the deferred payments. Of the 23,992 houses connected up to Feb. 22, 1900, the board had done the work in 8,763 on application, and in 3,292 on compulsion, while 11,937 connections had been made privately. A large proportion of the owners had taken advantage of the instalment plan of payment.

The average cost of plumbing and connecting 8,496 houses was about $95 each. The cost of the work for 23 houses, each having three plumbing fixtures, ranged from $55 to $130. The average cost of the work for 1,710 houses in the city of Melbourne was about $140, divided as follows: House connection, $55; plumbing $50; carpentry, $15; bricklaying, $20. The prices charged to householders are actual cost, plus 10%, which is designed to cover testing, storage and booking of materials and the expenses incidental to managing labor. Mr. Thwaites says that fair wages are paid to all employees, and that materials are obtained by contract in the open market. There is no attempt to underbid private contractors.

During the week ending Feb. 22, 1900, the board employed 400 men on house drainage and 165 on plumbing, making 565 in all, working on 540 houses. Private contractors employed, during the same week, 649 men on house drainage and 552 on plumbing, or a total of 1,201, on 976 houses. Altogether, there were 1,764 men engaged in these two classes of work, on 1,516 houses. Mr. Thwaites says that the chief critisism of the work in these branches is that it is too well done, but he adds:

> The health of a dweller in a £20 a year cottage is just as well worth caring for as that of the owner of a £200 a year house, and the sanitary work in the cottage should, except for materials, be as well carried out and as vigorously inspected as that of the mansion.

The variety and number of plumbing fixtures in the 23,992 houses connected to Feb. 22, 1900, was as follows: Water-closets, 25,714; baths, 15,305; sinks, 12,592; lavatories, 4,717; urinals, 2,210; cellars, 409; wash troughs (laundry tubs?), 7,487; latrines, 38; slop hoppers, 338; stables, 1,201; paved yards, 140; dairies, 21.

Vitrified sewer pipes from 4 to 20 ins. in diameter have been used throughout the collecting system. Of a total of 318 miles thus far laid there are 78 miles of 4-in., 75 miles of 6-in., 146 miles of 9-in., 9 miles of 12-in., 5 miles of 15-in., and 3 miles of 18-in. pipe. About 450 miles of pipe are required to complete the system, as planned. The ventilation is through manhole covers, so far as possible, in addition to which there are 2,390 special shafts, from 4 to 15 ins. in diameter, and from 30 to 80 ft. high.

The branch and main collectors, in addition to the minor collecting system already mentioned, are included in two main systems, the South Yarra and North Yarra, of various sizes, shapes and materials, from comparatively small sewer pipe to masonry sewers 9 ft. in diameter. About seven miles of these sewers were in tunnels, lined with stone and concrete blocks, cast-iron and concrete and wood and concrete, the iron and wood serving as outer shells. As already stated, the shield tunneling work will be treated in a separate article.

Each of the large trunk sewers, which are about 9 ft. in diameter at their lower ends, terminates in a pumping station, with a separate division for each system, so arranged, however, that it can draw sewage from the other outlet. Eventually, 20 pumping engines, of 300 HP. each, are proposed. Four of these are now in place and wells have been constructed for eight more. The present population will require double the pumping capacity thus far installed, or eight pumping engines.

The machinery consists of triple expansion condensing Worthington pumping engines, each with four 32-in. single-acting plungers, in pairs, one plunger being driven by a high and intermediate steam cylinder and the other by the low-pressure cylinder of each pair. The cylinders have diameters of 24⅛, 26⅛ and 16¾ ins., and a 36-in. stroke, with a maximum of 16 strokes per minute. Each engine can raise 1,000 cu. ft. per minute into the outfall sewer, with an expenditure of not over 112 lbs. of Newcastle (New South Wales) coal per 95,000,000 ft.-lbs. of sewage, the coal being rated at 13,000 B. T. U., as obtained by a Mahler calorimeter. This is equivalent to a duty of 65,250,000 ft.-lbs. per 1,000,000 B. T. U.

The South Yarra main sewer enters the building at 45 ft. below low water, and the North Yarra main at 37 ft. The pumps discharge the sewage at 64½ ft. above low water, so the total lifts are 109½ and 101½ ft., for the Southern and Northern divisions, respectively, without friction head.

The steam for the four engines is from six internally-fired return-tube boilers, the heated gases returning over the top of the boilers and thence through a Green's economizer for heating the feed water.

The sewage enters the station through straining wells, one for each system, each 22 ft. in diameter, and each provided with two straining cages, one of which is always in place. Steam winches lift the cages to the straining-house, the floor of which is 12½ ft. above low water mark. The material removed from the cages is placed in a Johnson drier and subjected to 45 lbs. pressure, which reduces it to a practically odorless mass, consisting chiefly of light floculent fiber, of little manurial value.

The total pumpage at the station in 1899 was 2,834,000,000 Imp. gallons, or about 3,400,000,000 U. S. gallons, and the corresponding amount of screenings from the cages was 357 long tons, which was reduced in the driers to 42 long tons, or about 28 lbs. per 1,000,000 U. S. gallons of sewage. The number of houses connected with the sewers increased from 8,287, Jan. 26, to 21,327 on Dec. 28, 1899. The total cost of wages, coal and other supplies and all repairs at the pumping station for 1899 was $28,620, or $8.04 per 1,000,000 gallons total lift. This lift is reported as 109½ ft. for the year, thus giving a cost of about 74 cts. per 1,000,000 gallons raised 1 ft. high.

Thus far, a 6-ft. and a 4-ft. force main have been laid, each 2¾ miles long to their termination at the upper end of the gravity outfall sewer. These mains are made of ¼-in. wrought iron. The 4-ft. main was laid in 30-ft. lengths, with lead-calked wrought-iron hub and socket joints. The 6-ft. main was laid in 15-ft. lengths, with every third joint hub and socket and the two intermediate ones flanged and bolted. All the pipe was dipped in a hot "asphaltum mixture, similar to what is used for the water supply pipes."

The outfall sewer is about 15¾ miles long, laid on a grade of 2 ft. per mile. Its ultimate size will be an internal diameter of 11 ft.; but only the lower half has been built, except where it is close to the main road or where the top of the arch is more than 5 ft. below the surface. Mr. Thwaites' description does not make it clear whether the outfall sewer was built of concrete with a brick lining, or wholly of concrete, with cement rendering.

The sewage is deodorized at the head of the outfall sewer, by forcing sulphurous acid into it by means of a Root blower, the acid being generated by burning sulphur. This was deemed necessary on account of the very objectionable odor at the point where the sewer discharges from the force mains. Another deodorizing station was being established, early in 1900, about five miles from the lower end of the outfall sewer.

The sewage farm includes 8,847 acres of land, bounded by Port Philip Bay on one side and the Werribee River on another side, and located nearly 20 miles from the pumping station. This land is divided as follows: Irrigable, 7,227 acres; grazing, 915; tree plantations, 357; private roads, 230; township sites, 102; reserved by the board, 16 acres. At one acre, gross, per 100 population, it will be seen that the farm would take care of the sewage of 884,700 people. Mr. Mansergh suggested one acre for 110 people, which would provide for a population of 973,170, or only a little less than the 1,000,000 inhabitants which the sewerage scheme is designed to serve some years hence. The purchase price of the land was $85.20 per acre. Up to June 30, 1899, only 576 acres had been graded for receiving sewage, but 1,590 acres had been plowed for irrigation, and 135 acres for trees, and 648 acres had been "mole-plowed." All the plowing had been done by steam. Mr. Mansergh recommended that the land be broken up by steam machinery to a depth of 18 or 24 ins., and properly drained. He estimated the cost of preparing the land for sewage at about $275 per acre, which included distributing channels and drains. The cost of preparation, thus far, appears to have been about $100 in excess of this, but the estimate was based on about ten times the area thus far completed. Up to June 30, 1899, a total of about $750,000 had been expended on the farm.

Tree planting was necessary for the protection of crops and stock. The brackishness of the subsoil water is a great hindrance to the establishment of crops, as has been the disturbance of the soil in grading. The application of sewage to the land gradually reduced the salt by 20% in one year. With sewage containing about 235 grains of salt per Imp. gallon, the effluent has shown from 413 to 712 grains. The drainage of the land and washing out of the salt really partakes of the nature of land reclamation, aside from the sewage farming.

On July 1, 1899, rents averaging about $3.50 per acre were being obtained from 5,937 acres of the farm, or nearly two-thirds the whole area, whereas about $3.20 per acre is required to pay interest. The sales and rents from the farm in 1898-9 amounted to $28,300, and the total expenses, including interest (but not sinking fund?) were $71,600, giving a loss, or net expense, of $43,313. There is little use in calculating unit prices, in view of the fact that the sewerage system and sewage farm are both in the early stages of development and use.

The areas graded to receive sewage are sown to lucerne and prairie grass, and eventually a large amount of stock will be kept to consume the fodder.

The main distributing channels are lined with concrete. The finished section ranges from a 45-in. radius at the northern end to an 18-ft. radius at the southern end, being a quadrant of a circle, with 1 to 1 slopes. Every 660 ft., branch carriers are taken off, composed of semi-circular cast-iron pipe, each carrier supplying a block of 20 acres, 18 of which can be irrigated. The land is underdrained by tile, or by means of a "mole-plow,"

the sub-drains delivering at intervals of 660 ft. into main channels 2,640 ft. apart, east and west, alternating with the branch carriers for distributing the sewage. All the effluent goes into a collector, which discharges into Port Philip Bay.

Analyses show that the farm effects the following bacterial and chemical reduction: Bacteria, 90%; free ammonia, 92%; albuminoid ammonia, 33%; oxygen consumed, 91%.

The total audited capital expenditure on account of the sewerage system and sewage farm, up to June 30, 1899, had been about $14,000,000. About $18,000,000 had also been spent on the metropolitan water supply, including the amount laid out by the general government before the board was created. The outstanding loans on March 1, 1900, nine months later, were nearly $13,000,000 for water supply and about $21,000,000 for sewerage. The rates of interest range from 3½ to 5%, but only about $6,000,000 bears more than 4%.

A SUBSTITUTE FOR BENZINE is demanded in Germany; and the late Chemical Congress at Hanover, offers a premium of the liberal sum of $250 for a substitute, or for a means of rendering benzine less dangerous.

THE BLOCK SIGNAL SYSTEM for Russian railways is being studied by the Russian Ministry of Ways of Communication. This department is now collecting expert data as to the working on Russian and foreign railways of all kinds of mechanical and electrical block-signal apparatus, with the view of selecting the one best adapted to Russian railways.

THE FIRST COTTON MILL IN EGYPT is nearly finished at Boulac. It was built by the Egyptian Cotton Mill Co., of London, under Mr. Allan F. Joseph, M. Inst. C. E., as technical adviser. The machinery is all English.

WIRELESS TELEGRAPHY, between Honolulu and the various islands of the Hawaiian group, has been successfully tested, and it is reported that practical working is regularly established. There are three stations now equipped; one at Honolulu, one at Hilo and one on the island of Lanai, the latter connecting the other two. From Lanai a cable runs to Maui.

THE INCREASE AND REORGANIZATION of the Corps of Civil Engineers, U. S. N., is recommended in his last report by Rear-Admiral M. T. Endicott, Chief of the Bureau of Yards and Docks. At the present time this corps includes 21 officers only, and is limited to this number by the personnel law. The enormous increase in the engineering work of the bureau, in the building of new dry docks, etc., urgently calls for the increase of this number, at least to 30 men. The amount of construction work now on hand is at least four times as much as it was prior to the Spanish war, and the present staff is subjected to much overwork. Attention is also called to the propriety of readjusting rank in this corps, so that it may be more in accordance with the important duties performed and more nearly equal the other staff corps of similar numbers. For example, among the 24 Chaplains, 4 rank with Captains and 7 with Commanders; among the 12 Professors, 3 and 4 rank with the above officers respectively; and among the 21 Naval Constructors, 5 rank with Captains and 5 with Commanders. In the Corps of Civil Engineers, with 21 men, 2 take rank as Captains and 2 as Commanders, and only 2 with Lieut.-Commanders. Chief of Bureau Endicott recommends that in the three higher grades named there should be 6, 5 and 6 Civil Engineer officers, leaving only 6 instead of 11 in the Lieutenant grade.

OCEAN STEAMER RECORDS FOR 1900 are discussed by the New York "Journal of Commerce," as to special fast trips. The "Deutschland" steamed from Cherbourg to New York, in 5 d. 12 h. 29 m., arriving at the latter port on Sept. 1. The previous best record for the same trip was 5 d. 17 h. 37 m., made by the "Kaiser Wilhelm der Grosse," arriving at New York on Nov. 21, 1899. The eastward record to Cherbourg is still held by the latter vessel, with 5 d. 15 h. 50 m. The "Kaiser Wilhelm der Grosse" also held the eastward record to Plymouth, with 5 d. 15 h. 10 m., until the "Deutschland" reduced this to 5 d. 15 h. 6 m., in July, 1900, and to 5 d. 7 h. 38 m. in September. The westward record from Plymouth is also held by the "Deutschland," with 5 d. 16 h. 24 m. On the Queenstown route, the "Lucania" holds the record, with 5 d. 8 h. 38 m. eastward, and 5 d. 7 h. 23 m. westward. All the other steamers crossing the Atlantic are at least "6-day boats."

THE BOILER EXPLOSION in the powerhouse of the Chicago & Northwestern Ry., which occurred Dec. 3, as described in our issues of Dec. 13 and 20, has been declared by the coroner's jury to have been due to the boiler plant being of insufficient capacity and worked too hard. We learn from official sources that the direct cause of the explosion was an old crack on the inner edge of one of the horizontal lap joints, the crack being partly between and partly outside the rivet holes. The crack was so situated, however, that is was practically impossible to see it. This form of joint is responsible for many cracks and failures of boilers, but is very commonly used for stationary boilers on account of its cheapness. For locomotive work, butt joints with cover plates or straps are universally used.

PROPERTY LOSS BY LIGHTNING in the United States is reported upon by Prof. J. Alfred Henry in the October, 1900, issue of the "Monthly Weather Review." The statistics given cover the calendar year of 1899, and were collected from special reports from the Farmers' Mutual Insurance companies and from newspaper clippings. Prof. Henry summarizes the results of the statistics as follows:

The total number of reports received of buildings struck and damaged or destroyed by lighting during the calendar year 1899 was 5,527, about three times as many as were received during the previous year. In addition to the above number, 729 buildings caught fire as a result of exposure to other buildings that had been set on fire by lightning. The approximate loss in the 2,825 known cases was $3,016,520, or an average loss of nearly $1,100 per building. It would not be correct to assume that the same rate of loss was maintained in the remaining 3,431 buildings, for, as a general rule, it is only in the small and insignificant cases of damage or loss that the details are lacking. The number of insured buildings in the United States struck by lightning during 1899, according to the Chronicle Fire Tables, New York, 1900, was 2,760, with a total loss, including exposures, of $3,913,525, or an average of a little over $1,400 per building. These figures are largely in excess of the corresponding values for 1897 and 1898. A considerable number of strokes was reported as falling upon various structures, such as windmills, derricks, oil tanks, water tanks, coal breakers, bridges, vessels, railway cars, threshing machines, etc. The damage to property of this kind so far as reported was $215,622. The number of electric power plants struck by lightning during the year was 79. Careful watch was kept for cases of overhead trolley cars being struck by lightning. Some well-authenticated cases of direct lightning stroke were observed, but in no instance was there loss of life or great destruction of property.

THE TIMBER EXPORTS OF THE UNITED STATES, including lumber and manufactured wood, amounted to $50,598,416 in the fiscal year ending June 30, 1900. The U. S. Bureau of Statistics says that the imports of corresponding products amounted to $20,591,908, leaving a very handsome balance of trade in our favor; about half of this import comes from Canada and the bulk of the remainder from tropical regions. The wooded area of the United States covers 1,094,496 sq. miles, or 37% of our territory; and we cut approximately 2% of our timber resources annually ;or 40 billions feet B. M., out of 1,830 to 2,300 billions of feet B. M. estimated as timber available. The Bureau does not believe, however, that we are in danger of a timber famine. It holds that as soon as the level of timber land values rises to the level of lumber prices, indiscriminate cutting will largely cease, scientific forestry will prevail and forest fires will be systematically prevented or controlled.

AN APPALACHIAN FOREST RESERVE is the subject of a bill before Congress. This bill would direct the Secretary of Agriculture to purchase not more than 2,000,000 acres of forest land in these mountains in Virginia, North and South Carolina, Georgia, Alabama and Tennessee, and to there establish a park. The purpose is stated to be the preservation of the richest hardwood forests of the United States and their scientific culture and utilization. This country is also one of the most picturesque and attractive in the United States; and the conservation of our water powers is also an important element in the project. The bill would appropriate $5,000,000 for the purchase of the land and development of the park.

THE HOLLAND SUBMARINE BOAT is not included in the naval appropriation bill, which carries a total of $78,000,000. Admirals O'Neil, Melville and Bradford demonstrated to the House Committee on Naval Affairs that the two boats for which the government was now paying $170,000 each could be duplicated for $50,000 each, if built in lots of four. They further contended that future naval wars would be short and sharp, and be fought with great armored fleets on the high seas; and the harbors were already effectively defended by forts and mines. Admiral Melville showed that the "Holland" could not, with her present speed, stem the ordinary tides at the entrance to New York Harbor, and had to depend on a tug for cruises to a point of attack. He further claims that there was not a single novel development of utility in her make-up, and no essential contrivance that is patentable. As a result, all attempts to include the further building of boats of this type in the naval bill were voted down.

THE GUATEMALAN RAILWAY CONTRACT, lately made with the Central American Improvement Co., of New Jersey, is summarized by U. S. Consul McNally, of Guatemala: The Guatemala Northern Ry. is to be completed from El Rancho to the City of Guatemala in 36 months; with 56-lb. steel rails, iron bridges, etc. To pay for building this 60 miles of road the government will issue $4,000,000 gold bonds, payable within ten years from commencement of this contract. As a guarantee Guatemala concedes to the company the operation of the line already constructed, from El Rancho to Puerto Barrios; and all properties connected with it, except the lands of Los Andes, owned by the Department of Public Works. The government will admit free of duty all material, etc., needed for construction; furnish right of way and necessary land free of cost; and furnish workmen up to the number of 6,000, each of whom is to receive $1.50, local currency, or 65.7 cts. per day, gold. Valuable rights are also conceded to the company in working the rich forests and fertile lands of Los Andes. At the end of ten years, the government is to pay the sum named and enter into possession of the railway; and in case of failure the company may retain and operate the whole line, and be paid 6% interest on the capital until the government can pay. If the government wishes to sell the road, the company has a preference.

THE INCREASE IN POPULATION in German towns is shown by the German census of Jan. 1, 1900. In the 32 principal cities this return for the five years, 1895-1900, ranges from a decrease in the case of Krefeld, to an increase of 58.6% in the case of Posen. Berlin has now 1,884,345 inhabitants; Hamburg, 704,669; Munich, 498,503; Leipzig, 455,120; Breslau, 422,415; Dresden, 395,349, and Cologne, 370,685. All others are below 300,000.

A SAN FRANCISCO COMMERCIAL MUSEUM, modeled on the one in Philadelphia, is to be established. A company has already been organized with Mr. Irving Scott as President, and the city is expected to add a generous sum to the money already pledged by private citizens. The purpose of the organization is the benefit of the commercial interests of California.

U. S. EXPORTS TO GERMANY for the eleven months ending December, 1900, amounted to a total of $179,134,409, says the U. S. Bureau of Statistics. The exports for the same period in 1895 aggregated only $79,563,594. In the total for 1900, cotton amounted to $68,922,915; corn, to $15,528,839; lard, to $11,036,881; copper, to $10,559,419; refined mineral oil, to $9,285,592, and oil cake and meal, to $3,931,828. As to the late proposition to increase the German rate of duty on wheat imported from 22.6 cts to 44 cts. per bushel, the Bureau states that only 5% of the total wheat exported from the United States goes to Germany; the total in the period named above being worth only $3,929,492, though this was only $592,759 in 1895.

SIX 5,000-HP. TURBINES for the new wheel-pit at Niagara Falls have been contracted for by the Niagara Falls Power Co. The wheels will be built by the J. P. Morris Co., of Philadelphia, Pa., who built the turbines in use in the present wheel-pit. The designs have been prepared by Escher, Wyss & Co., of Zurich, Switzerland, and will differ from the present turbines, which were designed by Piccard, Pictet & Co., of Geneva, Switzerland, principally by having the guides and buckets enclosed in the wheel case and having draft tubes which will allow the utilization of the full head of water available. The turbines are to be delivered in August and the generators were ordered from the General Electric Co., of Schenectady, N.Y., last November. Mr. Clemens Herschel, M.Am.Soc.C.E., is Consulting Hydraulic Engineer for the Niagara Falls Power Co.

RUBBER FROM THE HULE PLANT is reported upon by Mr. P. M. Griffith, American Consul at Matamoras, Mexico. This plant is a species of sage brush, with small leaves and grows to a height of about 3 ft.; it grows in the mountainous regions of Mexico, and in Texas, Wyoming and Nebraska, and is said to contain 40% of rubber. A process for extracting this rubber was discovered and patented by a Mexican living at Sierra Mojado, and a manufacturing plant has been established at San Luis Potosi by the Monterey Foundry & Manufacturing Co., of Monterey. The plant is automatically fed into cutters, and the cuttings are then lifted by a chain of buckets and dumped into a steam-jacketed mixing tank containing chemicals. The product runs into a hydraulic filter apparatus, where it is subjected to a hydrostatic pressure of 75 lbs. to the sq. in.; the material then runs into settling tanks, where the heavier gum sinks to the bottom and the chemicals and residue are drawn off. The cost of production is said to be slight; but the transport of the material is the chief difficulty, owing to the high freight rates. No mention is made of the quality of the rubber produced.

THE PRICES OF IRON AND STEEL.

The accompanying diagram, which we reproduce from the "Iron Trade Review," shows graphically the fluctuations of the prices of iron and steel during the last six years. It will be viewed with interest both as a matter of history and as an indication of what may be expected in succeeding years. The period of 1896-98 was one of abnormally low prices, and during that period few new

mills and furnaces were built, and old and small plants were allowed to stand idle. When the market picked up in the beginning of the year 1899 there was not sufficient reserve capacity to meet the increasing demand. The result of the boom in prices has been the construction of new and larger plants and the rebuilding of old ones, and the iron producers will be able to meet the needs of the country for some years to come. Although prices now have a slightly upward trend, very high prices are not to be expected in the near future. On the other hand, very low prices are also not probable. However, if a falling off in the home demand, caused, perhaps, by a period of general industrial depression, should occur, or sharp competition between the great producers should commence, the improved facilities for production which we now have will enable the manufacturers of this country to place iron and steel upon the markets of the world at prices below all previous records.

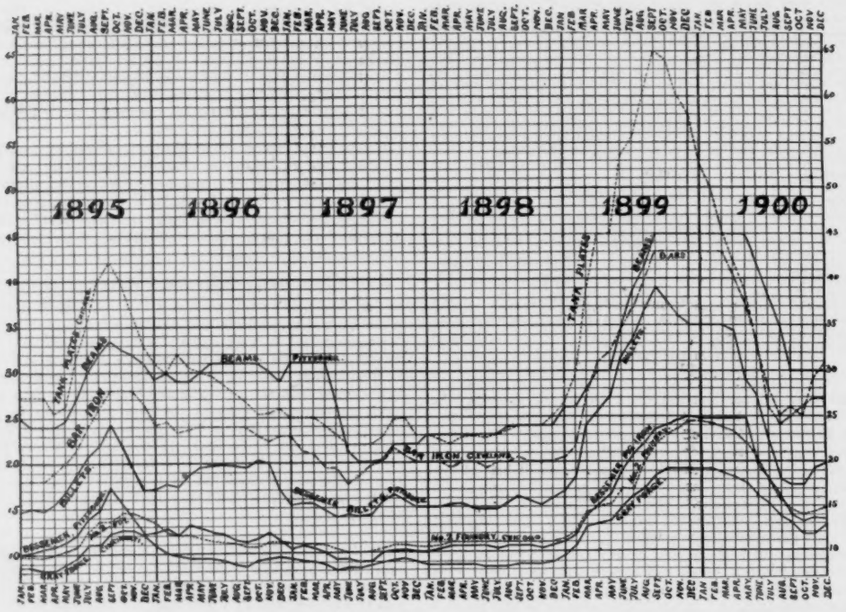


DIAGRAM SHOWING FLUCTUATIONS IN THE PRICES OF IRON AND STEEL IN THE PERIOD 1895-1900.

Prices of Pig-Iron and Billets in Dollars per Gross Ton; Plates, Beams and Bar-Iron in Dollars per Net Ton.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The first session of the 48th annual meeting of the American Society of Civil Engineers was held Wednesday forenoon, Jan. 16, in the Society's house at 220 West 57th St., New York city. This was, as usual, a business session and was devoted chiefly to hearing and discussing the annual report of the Board of Direction, a brief abstract of which follows:

The new members admitted during the year number 255, while the loss in membership from death and other causes amounts to 117, leaving a net increase of 138, which is the largest annual increase in the history of the society. The total number of applications received during the year was 308.

The increase in the number of candidates defeated by ballot leads the board to the belief that there is not a full understanding as to the care with which all applications are considered, and the weight which is always given to confidential communications in regard to any candidate. It is believed that whenever the use of a negative vote is justifiable, the candidate would not be passed to ballot if all available information were placed in the hands of the board, and the fact that some of those who are defeated on the first ballot are again passed to a reconsideration ballot, and thereon elected, means either that the case against the applicant is not a good one, or that the board has not been supplied with information on which a refusal to pass his name to ballot could be based. It is not intended to criticise in any way the exercise of the right of suffrage, but to express the belief that members, generally, do not understand that the most certain and effectual manner in which to prevent the election of an undesirable candidate is to place in the hands of the board the reasons which would inpel them to cast a negative vote. If the monthly blue lists were carefully scanned, and each person connected with the society would feel it his duty to give the board the benefit of his knowledge of any applicant, it is confidently believed that better results would obtain, and that the special reconsideration ballot would be much less frequent and possibly disappear.

The additions to the library during the year number 1,021, consisting of bound volumes, specifications, etc. The total attendance registered in the reading room has been 1,784. The work of reclassifying and indexing the library, which has been in progress for more than two years, has been completed, and a catalogue, a volume of 703 pages, covering 15,824 titles, which represent 32,788 volumes, pamphlets, maps, photographs, specifications, etc., has been printed and distributed to all persons connected with the society.

The board desires to emphasize the suggestion made in the circular issued with the catalogue, that an effort on the part of each member would soon result in filling many of the incomplete sets of reports, etc., now on our shelves. The completion of the index places the library in a far better position than ever before, and it will now be possible by judicious purchase to secure many volumes which should be available for reference.

The board has recently authorized the secretary to prepare a general index to the 34 volumes of the Transactions, which it believes will be ready within the next few months.

During the year 25 meetings have been held. At these meetings 18 formal papers were presented.

The 32d annual convention, held in the house of the Institution of Civil Engineers, in London, was most successful. There were present at that meeting 68 members of the society accompanied by 55 members of their families. The views of the board in relation to this meeting were expressed in a recent communication to the Institution in the following words:

"Your cordial invitation to visit London, in a more or less organized body, during 1900, was accepted in the belief that a material and lasting benefit would be derived from the holding of a meeting of engineers which would be international in character.

"The meeting of this society, held in the home of the parent engineering association of the world, brought together, for the exchange of professional views, a large number of engineers, comprising representatives from nine widely separated nations, and it is believed that the interest manifested, and the resulting technical discussions, fully justified the inauguration of such international meetings."

The Norman Medal, for the year ending with the month of July, 1899, was awarded to E. Herbert Stone, M. Am. Soc. C. E., for his paper on "The Determination of Safe Working Stress for Railway Bridges of Wrought Iron and Steel." The Thomas Fitch Rowland Prize, for the year ending with the month of July, 1899, was awarded to R. S. Buck, M. Am. Soc. C. E., for his paper, entitled "The Niagara Railway Arch." The Collingwood Prize for Juniors, for the year ending with the month of July, 1899, was awarded to Julius Kahn, Jun. Am. Soc. C. E. (now Assoc. M. Am. Soc. C. E.), for his paper, entitled "The Coal Hoists of the Calumet and Hecla Mining Company."

The financial affairs of the society are in excellent condition. During the year, notwithstanding the additional expenses incident to the constantly increasing regular work, and the preparation and issue of the new "Catalogue of the Library," a payment of $10,000 on the principal of the mortgage indebtedness has been made. In the last report of the board a recommendation was made that a sum approximately equal to the amount of the entrance fees received each year be applied to the extinguishment of the debt. The entrance fees received during the past year amounted to $4,905, and it is the intention to make a payment in 1901 of $5,000, thus reducing the debt to $70,000.

The report of the treasurer for the year ending Dec. 31, 1900, is as follows:

Balance on hand Dec. 31, 1899		$13,728.36
Receipts from current sources, Jan. 1 to Dec. 31, 1900		51,495.28
Received from sale of Historical Sketch		45.00
Payment on audited vouchers for current business, Jan. 1 to Dec. 31, 1900	$45,338.82	
Payment on principal of bond and mortgage	10,000.00	
Balance on hand Dec. 31, 1900:		
In Union Trust Co.	$4,597.24	
In Garfield Nat'l Bank	4,347.58	
In hands of the treasurer	985.00	9,929.82
		$65,268.64

That part of the report referring to the increase in the number of candidates defeated by ballot elicited much comment, but no action was taken in regard to the matter. It was suggested that there would probably be a lower number of candidates defeated if the board would always require a statement of the reasons for a negative vote.

The secretary announced the names of the winners of the medals and prizes for the year ending July, 1900, as follows: the Norman Medal, to James A. Seddon, M. Am. Soc. C. E.; the Rowland Prize, to Allen Hazen, M. Am. Soc. C. E.; the Collingwood Prize for Juniors, to Robert B. Woods, Jun. Am. Soc. C. E.

An amendment to Section 5 of Article 2 of the Constitution, to enable the Board of Direction at its discretion to advance Juniors about 30 years of age to a higher grade of membership was next discussed. The general sentiment of the meeting was against changing the present provisions of the Constitution.

The tellers reported the election of the regular nominees, as follows: President, J. James R. Croes, of New York city; Vice-Presidents, Henry S. Haines, of New York city, and George H. Benzenberg, of Milwaukee, Wis.; Treasurer, Joseph M. Knap, of New York city; Directors, Josiah A. Briggs, of New York city; George F. Swain, of Boston, Mass.; Emil Kuichling, of Rochester, N. Y., and Mordecai T. Endicott, of Washington, D. C.

The afternoon was devoted to an inspection, under the guidance of the several Division Engineers, of the work now progressing upon the New York Rapid Transit Tunnel, and in the evening a reception was held at the house of the society for the members and the ladies of their families.

On Thursday an excursion was made by steamer to engineering works of interest about New York Harbor, including the Water-Side Power Station of the New York Gas & Electric Light, Heat & Power Co., the power station of the Manhattan Railway Co., the New East River Bridge, and the works of the Department of Docks and Ferries.

At the evening session Mr. Elwood Mead, M. Am. Soc. C. E., Expert in Charge of Irrigation Investigations, U. S. Department of Agriculture, read a paper describing the irrigation methods in use in the arid regions of the West. Lantern slides were exhibited showing unirrigated and irrigated lands in that region, some of the canals and headgates of irrigation systems and diagrams setting forth the results of investigations made by the Department concerning the amounts of water used at different times of the year, etc.

The remainder of the evening after the reading of Mr. Mead's paper was devoted to a "smoker."

On Friday a visit was made to the mines and works of the Arlington Copper Co., of Arlington, N. J. The following description has been prepared by Mr. J. H. Granberry, Jun. Am. Soc. C. E., Engineer in Charge of Construction:

The mine is the old Schuyler mine which was worked intermittently from 1719 to 1862, over 30 shafts having, up to that time, been sunk to the copper-bearing rock. Some of these shafts are now opened, and others are being opened with a view to a more thorough exploration and development. The deepest shaft is 240 ft. deep, and the entire mine is drained down to the 100 ft. level by a drain tunnel 1,300 ft. long.

It is intended to run a drift through the center of the property, making cross-cuts as far as the property lines, and remove the ore by these cross-cuts and drifts. This method is similar to that used in anthracite coal mining.

The ore will be removed from the mine by a double-track cable road which will run through the main drift. The cars will be automatically dumped into the crushers, which reduces the material to about 1½-in. cubes. From the crusher the material drops into an ore bin with a capacity of 500 tons where it is dried, and thus prepared for dry rolling and pulverizing. From the ore bin the material drops into a set of Fraser & Chalmers crushing rolls, and being reduced to about ¼-in. in size, is conveyed thence into two pulverizing machines which grind up all the material so that it will pass through a 40-mesh screen. This resulting sand is then roasted in a furnace with a hearth 10 × 200 ft., being stirred mechanically and drawn against the action of the fire to the far end, where it is discharged into a trough. Above this level there are two solution tanks containing dilute sulphuric acid, which is fed directly upon the heated sand, forming a slush which is washed into four wooden tanks 30 ft. in diameter, with a capacity of 125 tons each. In these tanks the solution attacks whatever copper may be present in the slush. The resulting solution of copper sulphate is then drawn off from these leaching or lixiviation tanks and is used in large vats as an electrolyte. The essential principle of operation in these vats is the electrolytic action caused by passing a current from one set of lead anode plates to a corresponding set of lead cathode plates. The copper, after reaching sufficient thickness upon the cathode plate, is stripped off and the resulting copper plates are hung in the solution again to receive a thicker coat, bringing the sheet copper up to the thickness required for market purposes. From the time the ore is loaded on the cars in the mine to the time that the copper is stripped off the lead plates in the deposition building, the work is entirely automatic and is either mechanical or by gravity. The process is the result of investigations and experimental work with this ore by Dr. N. S. Keith, Consulting Engineer and Metallurgist of the company.

The plant has been designed, and is now being erected. The buildings are of steel and corrugated iron, with the exception of the power house, which will be of stone with a steel roof.

It is hoped to give a more complete description of this plant with plans and drawings in some future issue of this journal.